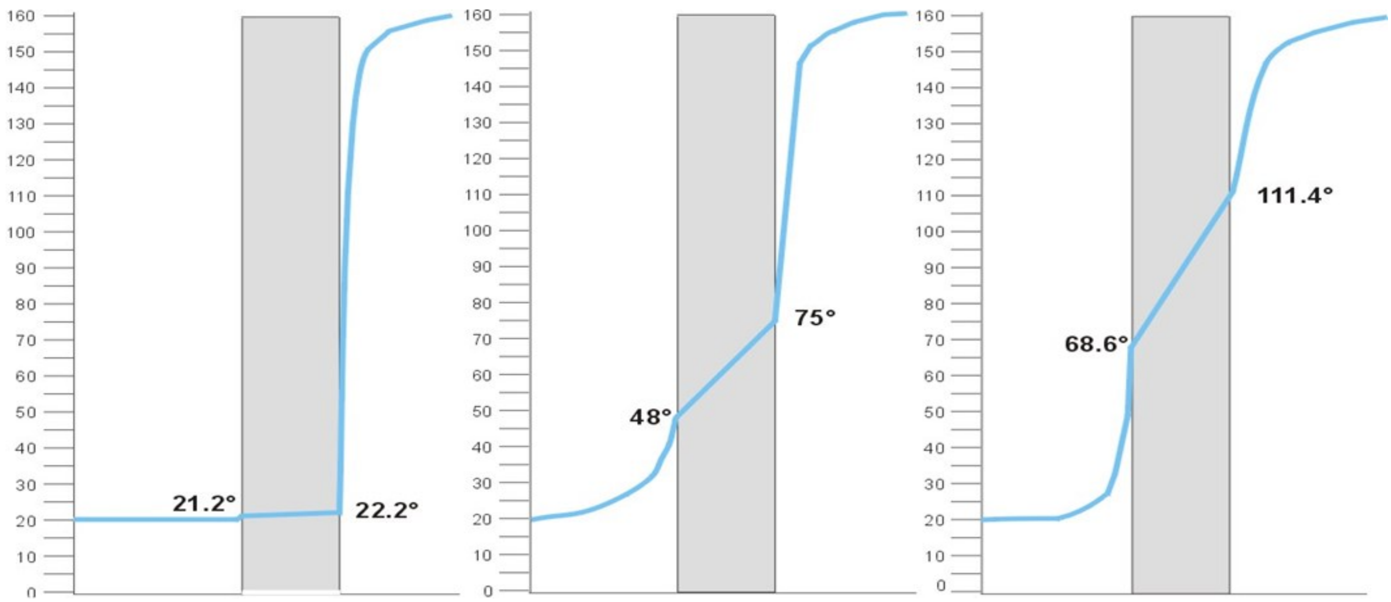
TI 022

Technical Information

Maximum Allowable Temperature Difference

It is very difficult to define a maximum temperature difference between operating media due to the influence of a number of factors. For example, the heat transfer coefficients, thermal conductivity, shape and thickness of graphite walls separating the media, any fouling or scaling as well as other possible sources of mechanical stress in the graphite e.g. pressure shocks or by swelling of the impregnation resin due to exposure to certain process media such as Methanol can all be influential.

The temperature change characteristics during the heat transfer through an even wall can be represented graphically as follows:



Example 1:
gas cooling:

Low heat transfer value on the warm side (50 W/m²K),
high heat transfer value on the cold side (6000 W/m²K)

Example 2:
condensation of solvents:

Medium heat transfer value on the warm side (2000 W/m²K),
high heat transfer value on the cold side (6000 W/m²K)

Example 3:
condensation of steam:

High heat transfer value on either side (6000 W/m²K each)

The simple graph above clearly shows the critical influence of heat transfer conditions on the temperature gradient in the graphite wall (in this example the wall is 15 mm thick with a thermal conductivity of 130 W/m²K).

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For example, a graphite heat exchanger could operate successfully in a system with hot flue gases at a temperature of 400°C, providing that coolant flow (e.g. water at 20°C) has been put in place first at a rate that is sufficient maintaining the graphite wall temperature at an acceptable level. The important point to note is that the flow of the higher heat transfer value media (in this case water) is established first. Had the hot gas flow been established first, the thermal shock caused by the introduction of the cooling water would certainly damage the heat exchanger.

As mentioned above in the introduction, another important source of mechanical stress for graphite is that caused by pressure shocks. This could typically be created by the rapid operation of valves (see TI 002). Exposure to certain media can also cause the impregnation resin to swell (see TI 020).

While these individual factors may not result in failure, their individual presence at non-critical levels can combine to result in the graphite materials' failure.

Please note: when installed and operated according to GAB Neumann recommendations WS 1501/1504, damage does not occur. This is endorsed by many years experience with our customers.

Summary:

The most critical consideration to take into account is the temperature difference / gradient across the graphite wall. The temperature difference between operating media is also important, and assessments should be made to consider the following factors:

1. If sufficient flow of the better heat transfer value media is established first (where both media are of different heat transfer coefficients), then, independent of the temperature, no critical thermal stress is caused.
2. With temperature differences through the graphite wall of more than 60°C (not difference in operating temperatures of the service and process media) damage becomes more likely and the resistance to pressure shocks is greatly reduced.
3. With exposure to certain (swelling) organic media (such as Methanol for example) the resistance of the material against thermal and/or pressure shocks can be greatly reduced.

Should you require any further explanations or information, please contact our technical department who would be pleased to give their advice about effects created by particular process conditions.