SAFETY STANDARDS

of the

Nuclear Safety Standards Commission (KTA)

KTA 3102.1

Reactor Core Design for High-Temperature Gas-Cooled Reactors
Part 1: Calculation of the Material Properties of Helium

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Comment:

In these English translations of KTA-Safety Standards the words shall, should and may are used with the following meanings:

shall	indicates a mandatory requirement,
should	indicates a requirement[1] to which exceptions are allowed. However, the exceptions shall be substantiated during the licensing procedure,
may	indicates a permission and is, thus, neither a requirement (with or without exceptions) nor a recommendation: recommendations are worded as such, e.g., "it is recommended that ....".

The word combinations basically shall/shall basically are used in the case of mandatory requirements to which specific exceptions (and only those!) are permitted. These exceptions - other than in the case of should - are specified in the text of the safety standard.

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1 Please note that in the case of IAEA NUSS standards and ANSI standards, the word “should” indicates a mere recommendation.

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Reactor Core Design for High-Temperature Gas-Cooled Reactor

Part 1: Calculation of the Material Properties of Helium

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PLEASE NOTE:

Only the original German version of this safety standard represents the joint resolution of the 50-member Nuclear Safety standards Commission (Kerntechnischer Ausschuss, KTA). The German version was made public in Bundesanzeiger No. 44a on March 4,1988. Copies may be ordered through the Carl Heymanns Verlag KG, Gereonstr. 18-32, D-5000 Köln 1.

Nuclear Safety Standards Commission (KTA)

Federal Republic of Germany

1 Scope

This safety standard applies to the calculation of the material properties of helium - mass density, specific heat, dynamic viscosity, thermal conductivity - in the ranges

1 bar < p < 100 bar for the pressure p

and

293 K < T < 1773 K for the temperature T.

2 Equations to be used

Note:

The equations below have been taken from the following literature "Helge Petersen, Ris3 Report No. 224 (9/70)".

2.1 Mass Density

For the calculation of the mass density p the following equation shall be used:

$$\rho = 48.14 \cdot \frac{p}{T}\left(1 + 0.4446 \cdot \frac{p}{T^{1.2}}\right)^{-1} \qquad (2\text{-}1)$$

with

ρ in kg/m^3

p in bar

T in K

The standard deviation is:

$$\sigma = 0{,}03 \cdot \sqrt{p} \quad \text{in}\,\% \qquad (2\text{-}2)$$

2.2 Specific Heat

For the calculation of the specific heat c the following equations [values] shall be used:

c_p = 5195 for constant pressure (2-3)

c_v = 3117 for constant volume (2-4)

with c_p and c_v in $\frac{J}{kg \cdot K}$

The standard deviation for c_p and c_v is:

$$\sigma = 0.05 \cdot p^{\left(0.6 - 0.1 \cdot \frac{T}{T_0}\right)} \quad \text{in}\,\% \qquad (2\text{-}5)$$

with

p in bar

T in K

T_0 = 273.16 K

2.3 Dynamic Viscosity

For the calculation of the dynamic viscosity η the following equation shall be used:

$$\eta = 3.674 \cdot 10^{-7} \cdot T^{0.7} \qquad (2\text{-}6)$$

with

η in Pa s

T in K

The standard deviation is:

$$\sigma = 0{,}0015 \cdot T \quad \text{in}\,\% \qquad (2\text{-}7)$$

2.4 Thermal Conductivity

For the calculation of the thermal conductivity λ the following equation shall be used:

$$\lambda = 2.682 \cdot 10^{-3}\left(1 + 1.123 \cdot 10^{-3} \cdot p\right) \cdot T^{0.71 \cdot \left(1 - 2 \cdot 10^{-4} \cdot p\right)} \qquad (2\text{-}8)$$

with

λ in $\frac{W}{m \cdot K}$

p in bar

T in K

The standard deviation is:

$$\sigma = 0{,}0035 \cdot T \quad \text{in}\,\% \qquad (2\text{-}9)$$