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Exercise 1 – Thermal Shock Parameters

Thermal Shock Parameters allow us to compare the thermal shock resistance of different materials by comparing fundamental properties like strength and thermal expansion.

In this exercise you should
1 – Rank the materials in order of thermal shock resistance based on your estimate/experience, without calculating a thermal shock parameter. The properties of five materials are listed below. Please do this part of the exercise BEFORE you reach for your calculator
2 – Calculate the thermal shock parameter (You can choose which one to calculate) and rank the materials again. Are there any surprises? Thermal shock parameter formula are given below.
3 – In service, thermal shock is only one consideration, other factors such as chemical resistance to the process are also critical. Rank the materials in order of suitability for the applications. Service conditions are given below.

MATERIAL PROPERTIES

Property and symbol	Silicon Carbide Brick	Mullite Brick	Magnesia Carbon Brick	Magnesia Chrome Brick	Fireclay Brick
Density, ρ (g/cm^3)	2.7	2.55	2.95	3.3	2.2
Thermal Conductivity, λ (W/mK)	14	2.5	11	4.6	1.8
Thermal Expansion, α ($x\ 10^{-5}\ °C^{-1}$)	4	4.5	13	10	6.5
MoR, σ_f (MPa)	45	14	15	12	6
Elastic Modulus, E (MPa)	50	40	0.95	15	15
Poisson's Ratio, ν	0.2	0.2	0.2	0.2	0.2
Specific Heat Capacity, c (J/kg.°C)	750	1100	750	850	1050
Work of Fracture, W_f (N/m)	50	48	130	150	36
Price per tonne	2800	1100	2300	2100	600
1 – Rank By Estimate					
Thermal Shock Parameter					
Rank by TSP					

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THERMAL SHOCK PARAMETERS

$$R = \frac{\sigma_f(1-\nu)}{\alpha.E}$$

$$R' = R\lambda = \frac{\sigma_f(1-\nu)\lambda}{E\alpha}$$

$$R'' = \frac{R'}{\rho.c} = \frac{\lambda\,(1-\nu)}{E\alpha\rho c}$$

$$R'''' = \frac{EW_f}{\sigma_f{}^2(1-\nu)}$$

$$R_{st} = \left(\frac{W_f}{\alpha^2 E}\right)^{1/2}$$