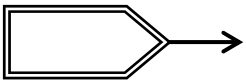
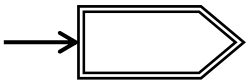
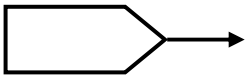
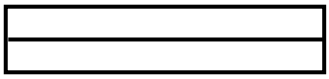
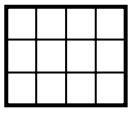
# APPENDIX A – MATERIAL PROPERTIES

| MATERIAL | COMPOSITION | DENSITY [$kg.m^{-3}$] | THERMAL CONDUCTIVITY [$kW.m^{-1}.°C^{-1}$] |
|---|---|---|---|
| Steel (Perry and Green, 1997) | 1.2% C, 0.3% Mn | 7800 | $2.0792\times10^{-8}\times T^2 - 4.69295\times10^{-5}\times T + 5.6235\times10^{-2}$ |
| Graphite Ramming Material (Weast and Astle, 1983) | 100% C (solid graphite) | 1700 | $1.066\times10^{-1}\times e^{-0.0011805\times T}$ |
| Magnesia Brick (Ruh and McDowell, 1962) | 93.6% MgO | 2787 | $1.1511\times10^{-2}\times e^{-0.0011304\times T}$ |
| Solid Slag | Values assumed to be valid for various typical high-$TiO_2$ slag compositions. | 3800 | 0.001 |
| Liquid Slag | Values assumed to be valid for various typical high-$TiO_2$ slag compositions. | 3800 | 0.001 |
| Liquid Metal | Dependant on the circumstances modelled. | Not used. | Not used. |

# APPENDIX B – MODEL ELEMENT DESCRIPTIONS

| NAME | ABBR. | SYMBOL | DESCRIPTION |
|---|---|---|---|
| Energy Flow Stream | EFS |  | An energy flow stream is used to connect modules with energy output ports and energy input ports. The flow stream receives energy from an output port and passes it to an input port. |
| Energy Input Module | EIM |  | An energy input module produces energy. The produced energy is made available at its output port where an energy flow stream receives it. |
| Energy Output Module | EOM |  | An energy output module extracts energy. It receives energy at its input port from an energy flow stream. |
| Energy Fraction Splitter | EXS |  | An energy fraction splitter is used to split the energy from one energy flow stream into two or more fractions. It makes the fractions available at its output ports where it is received by two or more energy flow streams. |
| Isothermal Module | ITM |  | An isothermal module represents a zone in a process that can be approximated as being isothermal. This module contains MMM, MRM, MXS and MPS modules. All the contained MMM modules are given the same temperature. |

| NAME | ABBR. | SYMBOL | DESCRIPTION |
|---|---|---|---|
| Material Flow Stream | MFS |  | A material flow stream is used to connect modules with material output ports and material input ports. The flow stream receives material from an output port and passes it to an input port. |
| Material Input Module | MIM |  | A material input module produces material. The produced material is made available at its output port where a material flow stream receives it. |
| Material Output Module | MOM |  | A material output module extracts material. It receives material at its input port from a material flow stream. |
| Material Fraction Splitter | MXS |  | A material fraction splitter is used to split the material from one material flow stream into two or more fractions. It makes the fractions available at its output ports where it is received by two or more material flow streams. |
| Material Phase Splitter | MPS |  | A material fraction splitter is used to split multiphase material into single phase material. The number of output ports is equal to the number of phases in the material received at its input port. |
| Material Reactor Module | MRM |  | A material reactor module is used to calculate the equilibrium condition of the material received at is input ports. The resulting material is delivered at its output ports as single-phase material. |
| Material Mixer Module (Ideal Mixer) | MMM |  | A material mixer module is used to represent a collection of material in a process that can be approximated as being ideally mixed. It can receive material at multiple input ports and deliver material to multiple output ports. |
| Conductor Module | CDM |  | A conductor module is used to conduction calculate heat transfer through, for example, a wall. It exchanges liquid material with a mixer module. It models solidification and melting of this liquid. |