The search for high-energy but low-sensitivity explosives has been the focus of many studies. It has been found that the use of cyclo-trimethylene-trinitramine (RDX) or cyclo-tetramethylene-tetranitramine (HMX) can maximize the energy of the explosive while minimizing its sensitivity. However, the preparation and processing of such explosives is a major challenge for military applications.

Melt casting and mechanical pressing are two of the most used approaches for explosives production. Of the two, melt casting is more economical for large-scale filling in munitions applications. A large amount of charge can be cast, even with very special shape. Explosives melt casting has traditionally been based on a trial-and-error approach. Further process and product improvements call for the development of a comprehensive numerical model that allow a systematic study of the melt casting process parameters and offer a better understanding of the physical mechanisms involved. The numerical modelling and simulation presented here are used to determine optimized casting parameters. High quality explosives can not be produced without well-controlled casting parameters.

**Inputs for the Model**

- **Explosive properties**
  - Density: \( \rho \)
  - Melting point: \( T_f \)
  - Latent heat of solidification: \( \Delta H_f \)
  - Thermal conductivity: \( k \)
  - Thermal expansion coefficient: \( \alpha \)
  - Viscosity: \( \eta \)

- **Conditions**
  - Initial temperature of metal and explosive: \( T_0 \)
  - Ambient air temperature: \( T_{ext} \)
  - Cooling conditions: conduction, free convection, forced convection

**Model**

- Heat transfer by conduction equation:
  \[
  \rho C_p \frac{\partial T}{\partial t} - \nabla \cdot (\kappa \nabla T) = Q
  \]

- Incompressible Navier-Stokes:
  \[
  \rho \left( \frac{\partial \vec{u}}{\partial t} + \vec{u} \cdot \nabla \vec{u} \right) + \rho \vec{g} = \nabla \cdot \tau
  \]

- Phase change during solidification:
  \[
  \Delta H_f \frac{\partial \phi}{\partial t} = \nabla \cdot \left( \frac{\rho \phi \Delta H_f}{T_f} \nabla T \right)
  \]

**Results of COMSOL 3.4 simulation:**

- Validation of the model: comparison between measured temperature and simulated temperature
- Solidification front evolution versus time is observed to determine the best cooling conditions
- Visualisation of stress/strain and shrinkage
- Visualisation of shrinkage, cavity formation and cracks

\[\text{This new model is a cost and time-effective tool to optimize the process parameters}\]