Thermal Validation of Air Break Disconnector

H. S. Saiger, I. Jain, G. Tapiawala
Raychem Innovation Centre, Raychem RPG Ltd, Vadodara, GJ, India

INTRODUCTION: Disconnectors provide electrical seclusion for maintenance in power systems. Disconnectors are subjected to a temperature rise due to continuous flow of current. As the temperature rise tests are time consuming, a model (Fig 1) is developed in COMSOL® including a coupled electromagnetic-thermal simulation to determine the temperature rise in the system for design verification.

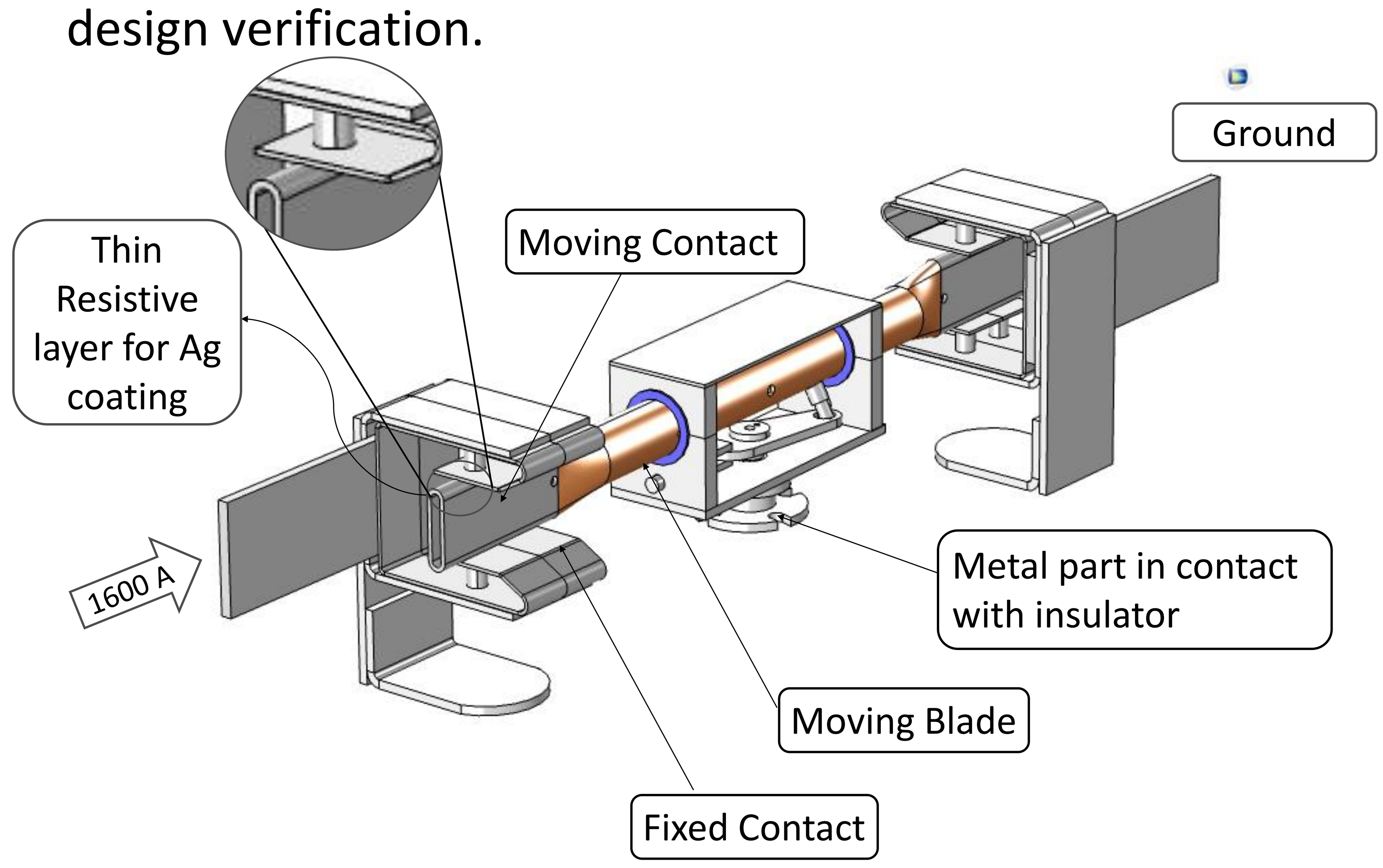

Figure 1. Model of Isolator

NUMERICAL MODEL (3D, Frequency Stationery)

- Model simulates the disconnector undergoing electromagnetic heating.
- Electric Currents (ec) and Magnetic Fields (mf) interfaces are coupled to obtain the finite element solution for volumetric electromagnetic losses.
- Contacts & connections are modelled separately to account for contact resistance in Heat Transfer in Solids (ht) interface as shown in Fig 2.

Electromagnetic Heating	Heat equation
$Q = \frac{1}{2} Re\,(J \cdot E + i\omega B \cdot H)$	$K\,(\frac{\partial^2 T}{\partial x^2} + \frac{\partial^2 T}{\partial y^2} + \frac{\partial^2 T}{\partial z^2}) = -Q$

Contact modelling:
- Constriction Conductance Model – Gap Conductance
- Thermal Friction – Electromagnetic losses

1. Main Contact modelling:
- Thermal Resistive Layer for Ag coated surfaces.
- Spring Contact Pressure of 70kPa

2. Bolted Connection modelling:
- No additional coating/layer
- Contact pressure of 80kPa for bolted connections

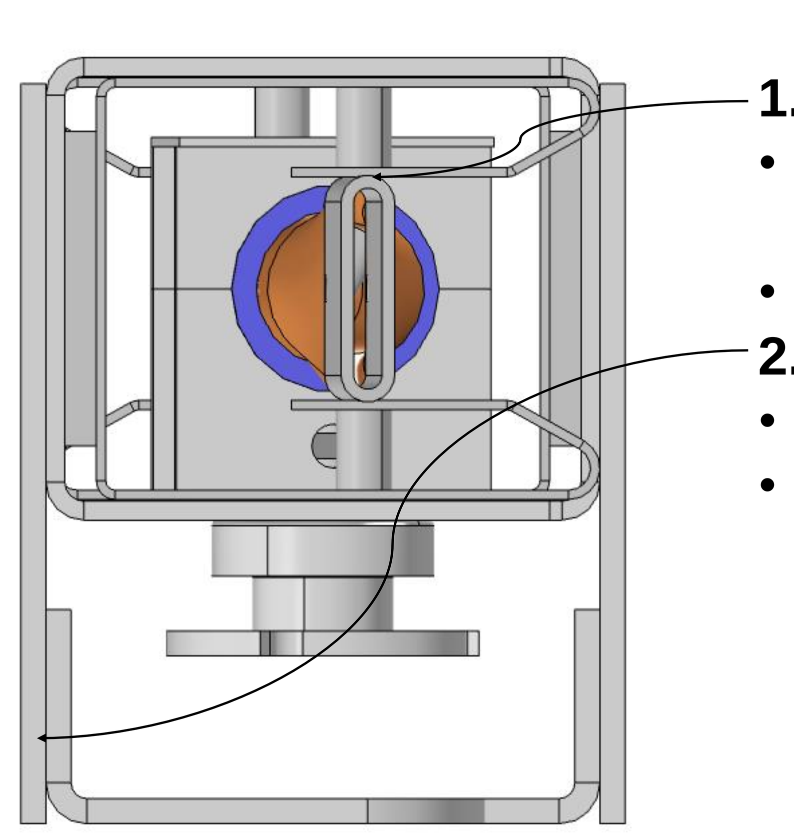

Figure 2. Contact & Connection Modelling

Part	Value W/m²K
Cylindrical (Rod)	3.5
Vertical & Horizontal Flats	4

Table 1. Heat transfer Coefficient values

RESULTS:
- The temperature rise results are obtained due to nominal flow of rated current as shown in Fig 3.
- The highest temperature rise is seen at the contacting area i.e. on Fixed & Moving Contact as shown in Fig 4.
- These values are the most important values in terms of steady state temperatures.

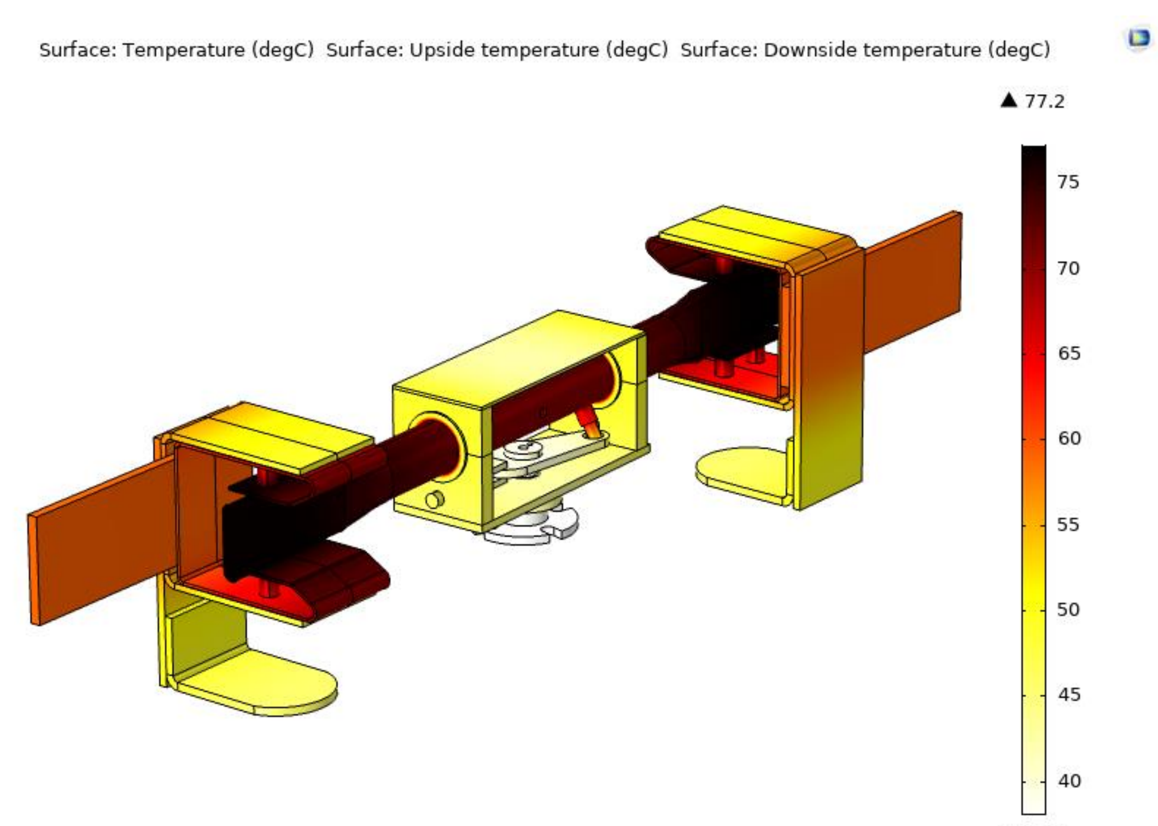

Figure 3. Temperature Plot For Isolator

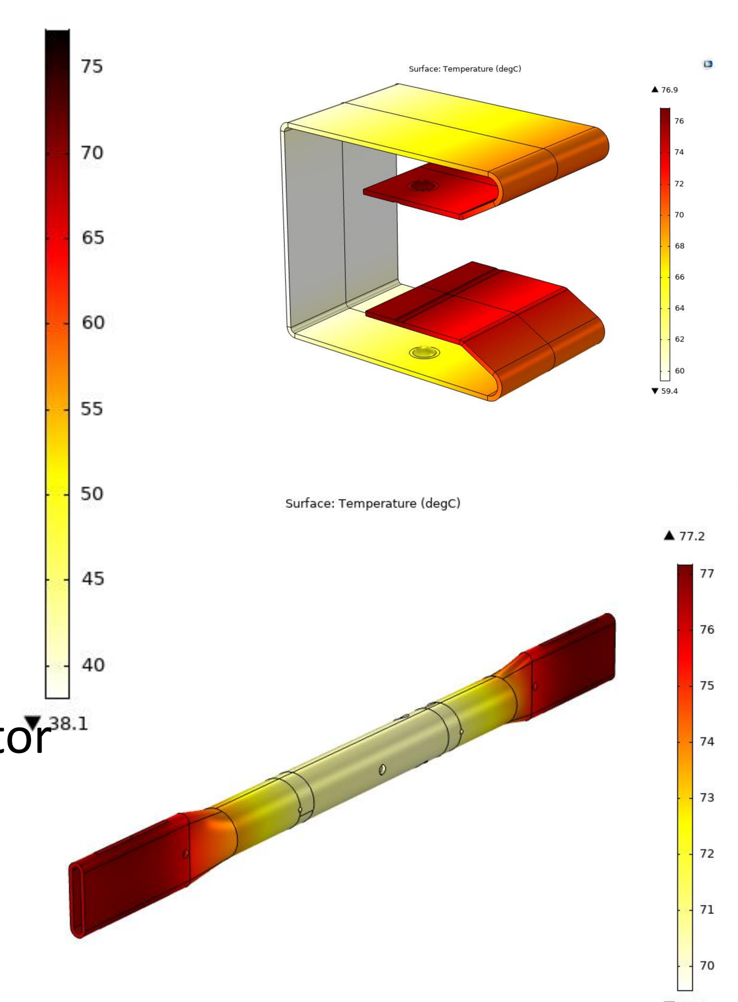

Figure 4. Temperature Plot for Contacts

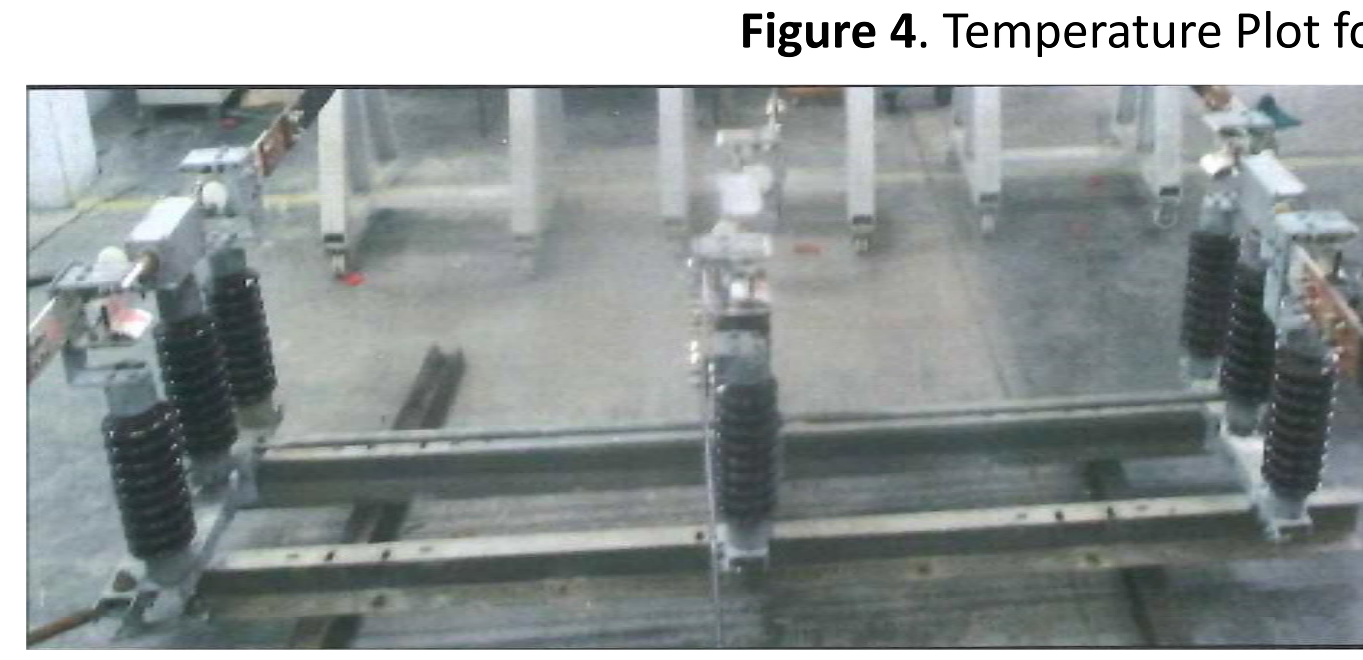

Figure 5. Test Object (3–phase)

Part	Sim Rise ° C	Exp Rise ° C	Variation %
Fingers	47	48.3	2
Moving Contact	47.2	48.4	2.5
Terminal Pad	31.2	37.6	17
Metal part in contact with insulator	8.1	7.4	-9

Table 2. Isolator Model Temp Rise Values Comparison

CONCLUSIONS:
- Simulation results are verified with test results.
- Thermal stability is analyzed and is certified with the threshold limit stated in IEC 62271-102:2018.
- Verified analysis can be extrapolated to reduce number of tests, to improve performance, to reduce cost for developing reliable design.

REFERENCES:

1. David Simek, The Thermal Model and Temperature Rise Test of Disconnector, FEEC BUT, Technicka 3082/12
2. IEC 62271-102:2018
3. COMSOL Heat Transfer Module Users Guide