India's Best Companies To Work For 2017
The Economic Times

Raychem RPG

ENGINEERING GROWTH
PIONEERING EXCELLENCE

TE RPG
(A TE-Connectivity - RPG Enterprises JV)

Thermal Validation of Air Break Disconnector

Hamza Saiger, Ishant Jain

Raychem RPG (P) Ltd.
Halol, Gujarat

Introduction

Raychem RPG

- **Disconnectors** : Off load switch
- Provide electrical & visible isolation of a system.
- **Major contributor** to **personal safety** in normal day to day operations & during maintenance.
- **Ratings:**
  - i. Medium Voltage
  - ii. High Voltage
  - iii. Extra High Voltage
- **Types:**

Pantograph

Double Break

Centre Break

Isolator Model analyzed:

33kV Double Break

(A TE-Connectivity - RPG Enterprises JV)

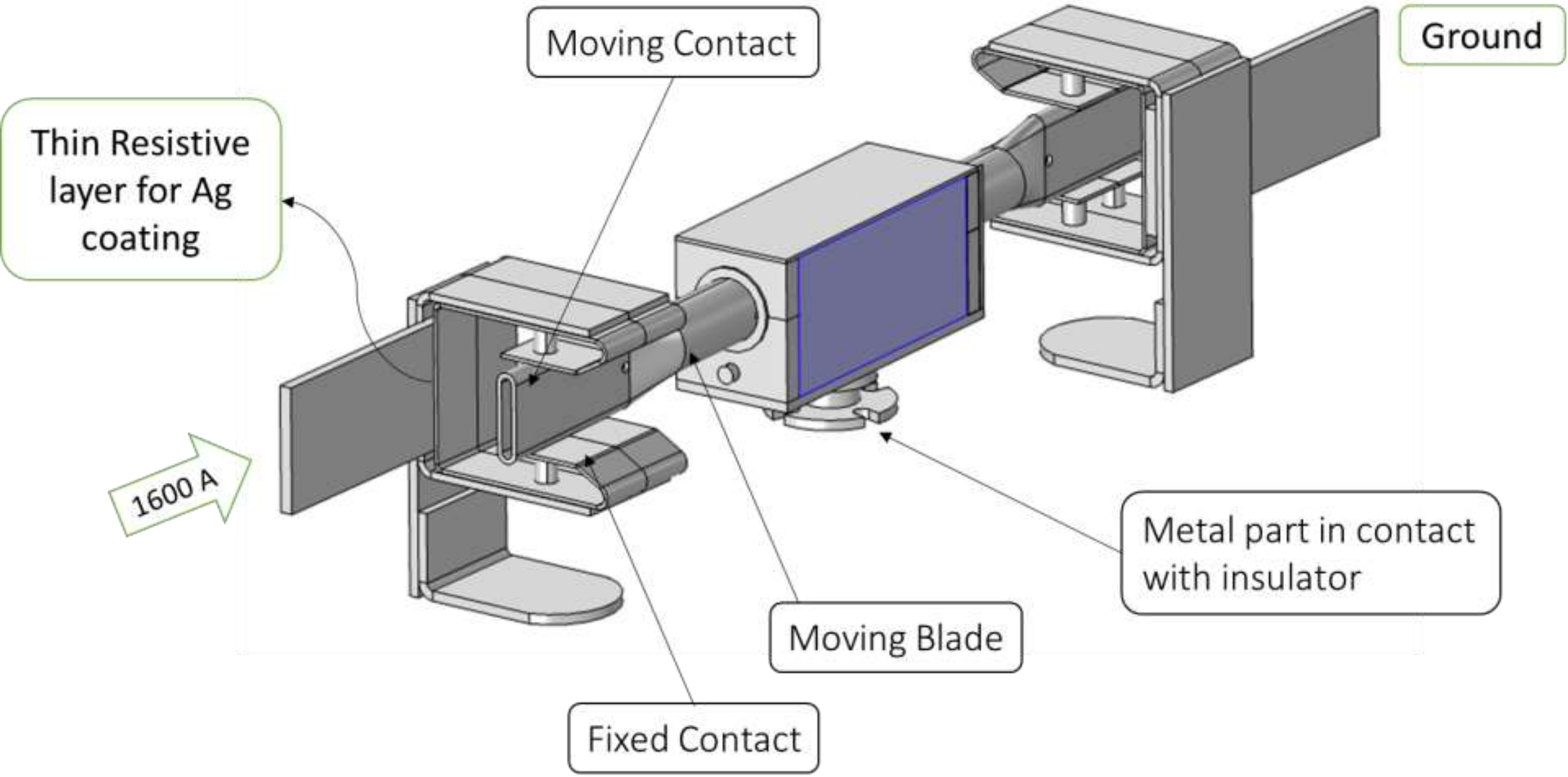
Purpose & Scope

- Continuous current flow (service condition)
- Ohmic losses & eddy current losses.
- Temp Rise in the system.
- Thermal aspect important in design.
- Design according to IEC acceptance criteria.
- Reliable Design- Performance & Cost optimized end product
- Testing- Time consuming/Expensive
- Wide range of products

Problem Definition

- To carry out **temperature rise analysis** of the disconnector as per IEC 62271-1:2017

Disconnector Model



Raychem RPG

Disconnector Model

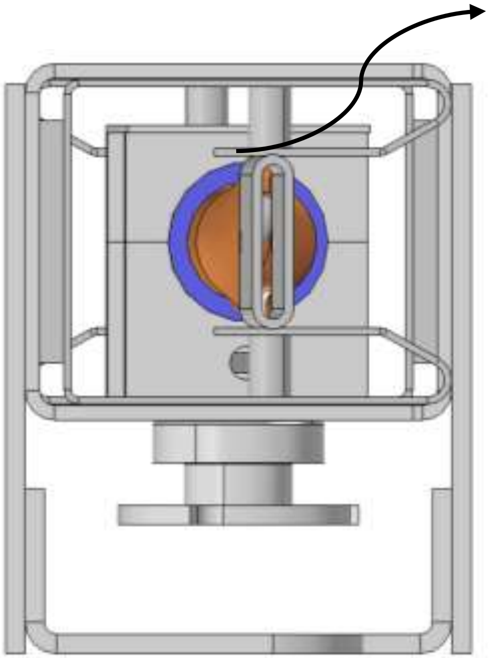
- Multiphysics: Electromagnetic Heating
- Model: Union Model
- Solver: Frequency Stationery
- Frequency = 50Hz

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

Ohmic loss

Eddy current loss

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
- Contact Resistance value.
- Surface Roughness:
  - Ag Plated 0.98µm
  - Aluminium 1.5µm

(A TE-Connectivity - RPG Enterprises JV)

Boundary Conditions – Heat Transfer

Raychem RPG

- Hardware : Excluded for ease of computation
- Heat transfer coefficient : natural convection
- Ambient Temperature: 30° C

Horizontal cylinder (in air)

$$h = 1.32\left(\frac{\Delta T}{D}\right)^{0.25} \quad \mathrm{W/m^2/^oC} \qquad [D = \text{diameter}]$$

Vertical plates and cylinders in air

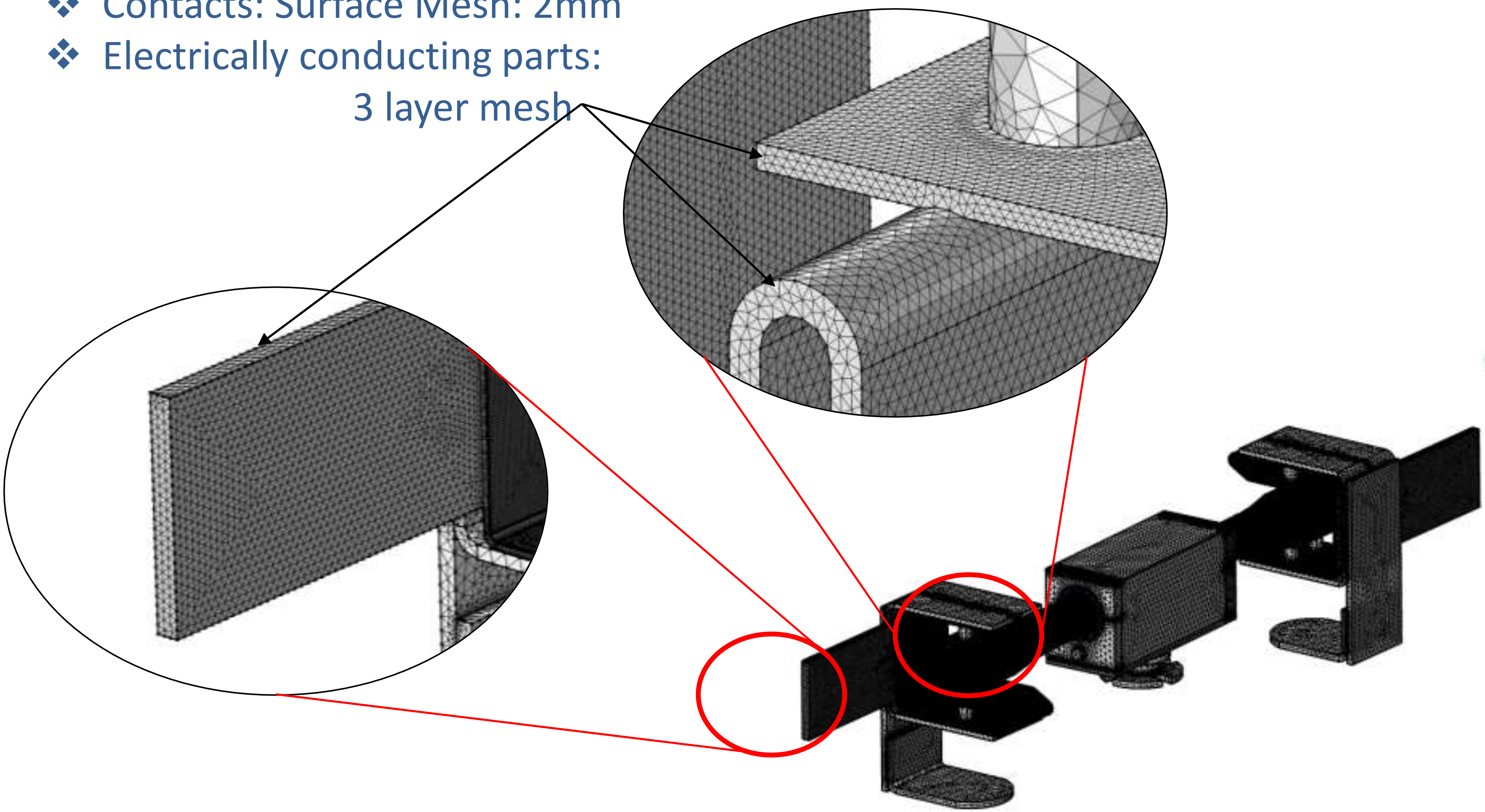
$$h = 1.37\left(\frac{\Delta T}{L}\right)^{0.25} \quad \mathrm{W/m^2/^oC} \qquad [L = \text{plate length}]$$

Part	Value (W/m^2K)
Cylindrical (Rod)	4(Outer Surface) 3.5(Inner Surface)
Vertical & Horizontal Flats	4

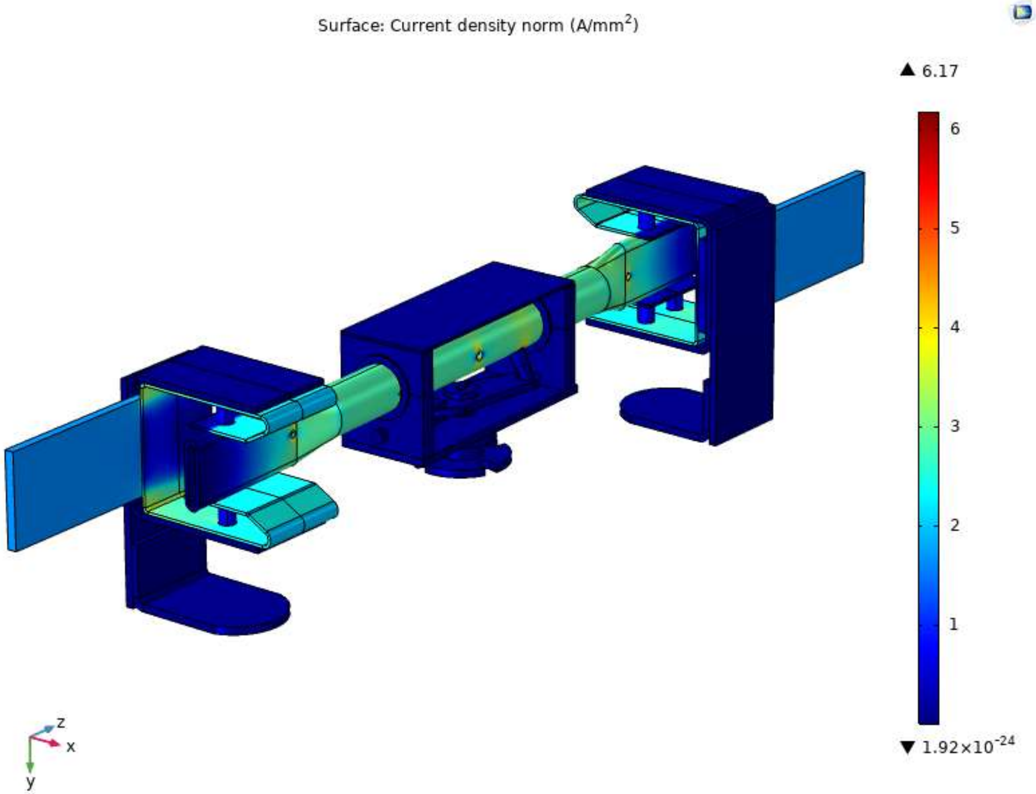
TE RPG
(A TE-Connectivity - RPG Enterprises JV)

Meshing

- Contacts: Surface Mesh: 2mm
- Electrically conducting parts:
  3 layer mesh



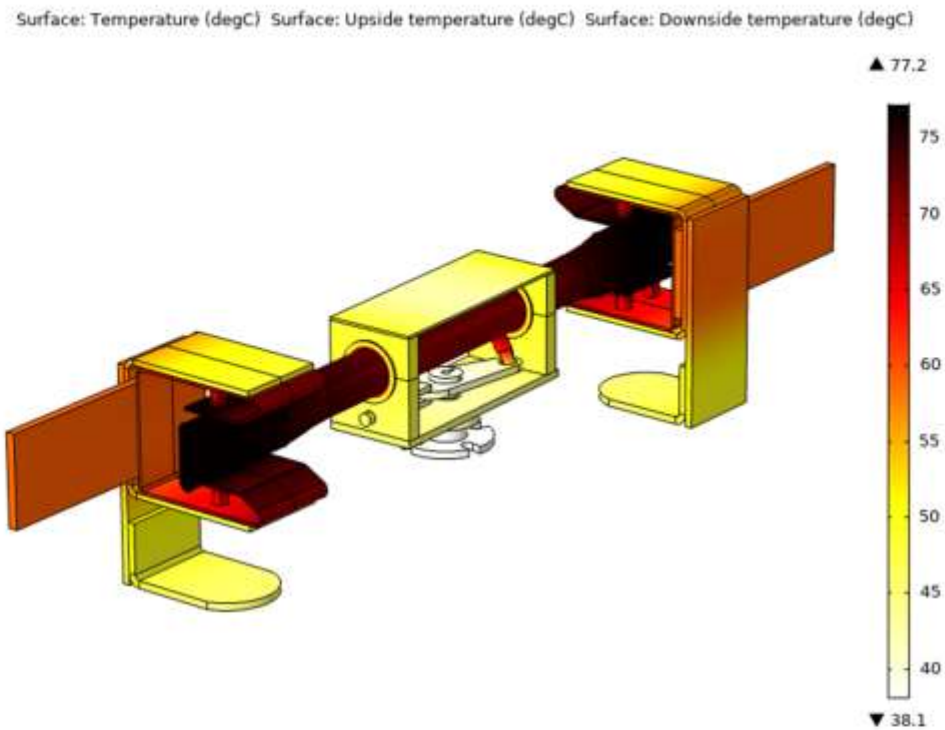
Results – Current Density

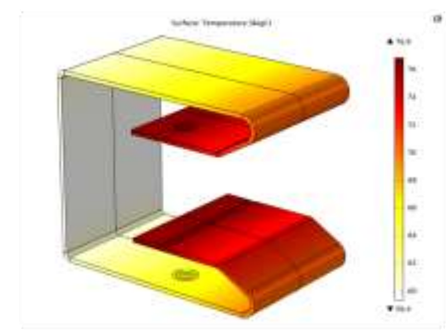


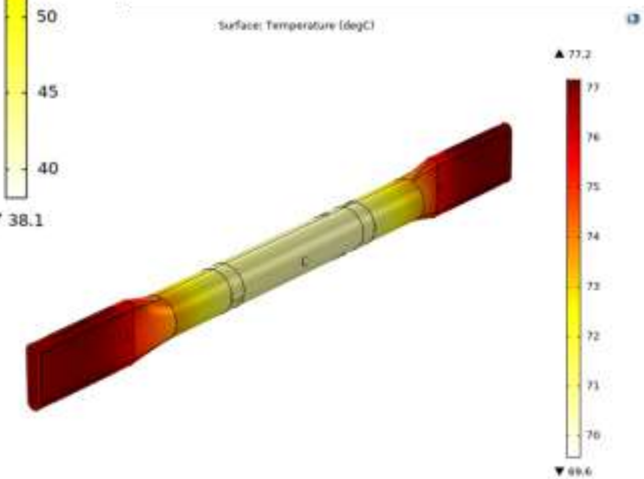
Discussion

- Maximum current density is seen near the main contact (localized).
- The current density of copper and aluminum parts found to be in reasonable limits.
- Induced current density : Negligible in all 3 directions
- Hence eddy current losses are negligible at 50Hz for isolator model.

Results – Temperature Profile







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

❖ Hotspots observed at main contacts.

Conclusion & Future Scope

- Simulation results are verified with test results @ ERDA, Vadodara.

- Thermal stability is analyzed and is certified with the threshold limit stated in IEC 62271-102:2017.

- Verified methodology & analysis can be extrapolated to
  - Identify failure points if any at design stage
  - Improve product performance
  - Reduce number of test iterations
  - Reduce design & testing cost
  - Develop reliable design.

Q&A