# NUMERICAL INVESTIGATION OF 1 kW MICROWAVE HEATING APPLICATOR FOR ENHANCED POWER ABSORPTION IN ASPHALT PAVEMENTS

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## ABSTRACT

The use of microwave energy for heating asphalt-based road construction materials in repair and rehabilitation applications holds practical importance due to its capability for rapid and volumetric energy delivery [1], [2]. However, microwave applicator systems employed for asphalt pavement heating often experience significant reflection losses and non-uniform electromagnetic power deposition due to impedance discontinuities between the antenna aperture and the lossy dielectric medium [3], [4]. In the present work, the influence of an impedance matching layer (IML) on the electromagnetic coupling and power absorption characteristics of a 1 kW horn antenna–asphalt slab system operating at 2.45 GHz is numerically investigated. A 3-D electromagnetic model consisting of a horn antenna, impedance matching layer and asphalt pavement was developed using CST Studio Suite. Parametric investigations were carried out to examine the influence of dielectric constant and layer thickness on the $S_{11}$, VSWR and volumetric power loss density distribution. The results demonstrated that the IML significantly improved impedance matching between the applicator and the asphalt slab. An optimum dielectric constant of 2.5 and layer thickness of 6 mm produced minimum VSWR values near the operating frequency of 2.45 GHz. The optimized configuration reduced the VSWR from 1.63 for the base configuration to approximately 1.28, indicating enhanced electromagnetic coupling and reduced reflection losses. To quantify the power absorption, threshold-based indices corresponding to power loss density levels of $P > 200$, $P > 400$ and $P > 800$ W/m$^3$ were evaluated. Compared with the base configuration, the optimized impedance matching layer increased the distributed power absorption region, indicating stronger localized field concentration resulting from enhanced microwave power coupling into the asphalt medium. The study demonstrates that impedance-engineered dielectric interlayers of the applicator can effectively improve microwave coupling and redistribute power.

## References

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