Laser additive manufacturing (LAM) is an emerging technology that builds parts in a layer-by-layer process by selectively melting metal powders. This additive manufacturing technique among others can produce very complex geometries for gas turbine components that are not possible using conventional casting methods. In the present study, a mock segment of the leading edge of a turbine blade fabricated by LAM of Inconel 718 powders is investigated; it is designed with an internal impingement cooling array and an engineered-porous structure. This porous region consists of a lattice of intersecting cylinders used to simulate the effect of a transpiration cooled segment or permeable wall. Transpiration cooling has been considered a promising external cooling technique capable of reducing thermal gradients at the surface of the blade by providing a more uniform film and higher adiabatic film cooling effectiveness than conventional discrete film cooling holes. In this current study, adiabatic film cooling effectiveness is experimentally investigated using pressure sensitive paint (PSP) at different blowing ratios. Using air as the mainstream flow or cross-flow and CO2 as the coolant source, a nominal density ratio of 1.5 is obtained. Results indicate higher coverage and film cooling effectiveness when increasing blowing ratio at the expense of higher pressure drop. Flow separation is observed at the highest blowing ratio. In addition, numerical analyses are performed using steady state Reynolds Average Navier Stokes (RANS) simulations and compared against experimental measurements.