A time-dependent analytical thermal model of the temperature and the corresponding induced thermal stresses in continuous wave double-end-pumped laser rod are derived from the first principle using the integral transform method. The aim of the paper is to study the effect of increasing the pumping powers while the laser crystals are still in the safe zone (i.e. far away from failure stress) and to suitably choose a crystal that achieves this task. The result of this work is compared with a well-verified finite element solution and a good agreement has been found. Some conclusions are obtained: Tm:YAP crystal, which has high thermal conductivity, low expansion coefficient, low absorption coefficient, low thermal factor and low product of $\gamma E/(1-\upsilon)$, is the best choice to reduce induced stress although it is responded and brought to thermal equilibrium faster than the other types of crystal usually used in the end-pumped solid-state laser.