measurement of the drill bit (with an infrared meter, after removal of the bit from the cylinder) showed a temperature increase of 35 °C, and fused polyethylene on the cutters suggest that some localized temperature increase of at least 150 °C took place.

Despite the likely malfunctions of the temperature measurement system, there is no conclusive evidence that there was any significant increase of the average temperature (of the order of 10 °C) of the bit during Test Cylinder #1. Assuming that $T_* \simeq 10$ °C – then, according to (3) where $D \simeq 0.1$ m and $\kappa_r \simeq 1$ W/m·K – we obtain that Q_r, the heat rate dissipated into the soil, is of order of 10 W, which is several orders of magnitude smaller than the power delivered at the bit.

4 Conclusions

While the thermal properties of the materials drilled by the RSI sonic bit lie within a fairly narrow range (see Appendix A), little is known of the heat generated by sonic drilling. The maximum mechanical power that could be delivered at the bit is in the range of 10^4 to 10^5 W, but only a fraction of this power is transformed into heat produced at the bit/soil interface. To estimate the average temperature that could be reached at the bit, the main issue is to determine the order of magnitude of this heat production rate Q at the interface.

Back-of-the-envelope calculations of the mechanical energy transferred between the bit and the soil, as described in this report, suggest that Q is less than 100 W. The simple model of a moving heat source was also used together with temperature data of the California Combustion Test to estimate Q_r (the fraction of Q dissipated into the soil, with $Q - Q_r$ corresponding to the heat carried away by conduction in the drill string) and to provide an estimate of the temperature at the bit. The moving heat source model shows the existence of two characteristic quantitities: the characteristic temperature $T_* \sim Q_r/\kappa_r D$ (which can be interpreted as a measure of the bit temperature) and the diffusion length $\lambda = C_r/V$. An examination of the temperature data within the framework of this model suggests that the observed temperature increase at the thermocouples of the order of 10 °C in Test Cylinder #1 is not real and is due to a malfunction of the measurement system. Taking $T_* \simeq 10$ °C, yields an estimate of only 10 W for the heat rate Q_r dissipated into the soil. As discussed above, it is difficult to reconcile the information regarding the measured temperature increase during the