ENERGY DISTRIBUTIONS IN EDM

Xia et al. [1,2,3] measured the energy distribution by comparing the measured temperatures of the electrodes with the calculated results obtained under the assumed ratio of the energy distributed in electrodes, using the calculation model and experimental setup shown in Figure 1. When the calculated temperature agreed with the measured one, they found that the estimated energy distribution was correct. Figure 2 shows the energy distribution obtained by Xia et al. when copper was used for both anode and cathode. They reported that the energy distributed into anode is always greater than that into cathode, and is rarely affected by the discharge duration, in both single discharge [1] and continuous pulse discharges [3]. Ratio of energy used for removal of electrodes is significantly low (1%), and 18% of the energy is lost into the gap.

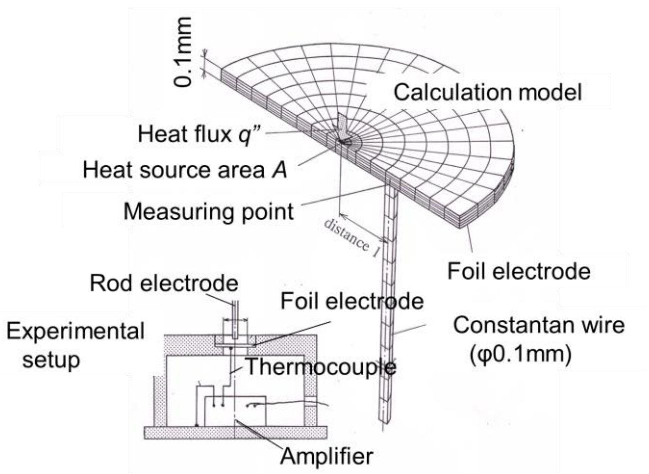
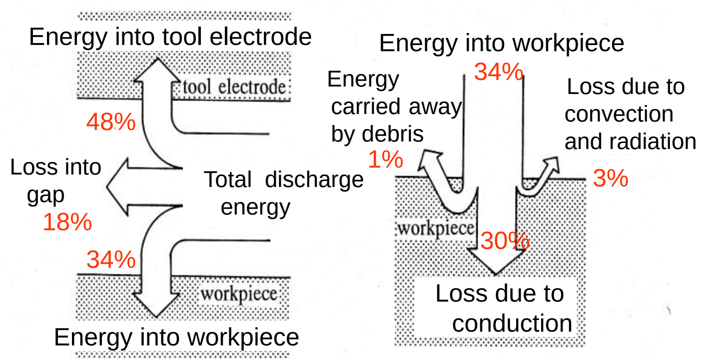


Figure 1: Method to obtain energy distributed into electrode in single pulse discharge.



(a) Distribution of discharge energy (b) Energy distribution in workpiece

Figure 2: Energy distribution in EDM process (I_e:16A, t_e:100μs , Cu(+) – Cu(-)).

On the other hand, Hayakawa et al. [4] found that almost 100% of the discharge power is conducted into the electrodes using discharge durations significantly longer than those used in the normal EDM processes as shown in Figure 3. This is because the arc column is established in steady state and both convection and radiation are insignificant in the narrow gap between parallel plane electrodes. Thus they concluded that the gap condition is not in equilibrium in the early stage of arc discharge, and a large fraction of the discharge power is consumed in the formation of plasma through ionization, excitation, dissociation, and polymerization. For micro EDM where discharge durations are comparatively short, Zahiruddin et al. measured the energy distribution in micro EDM [5] and found that more than 85% of the total discharge energy is used for the generation and enthalpy increase of the plasma.

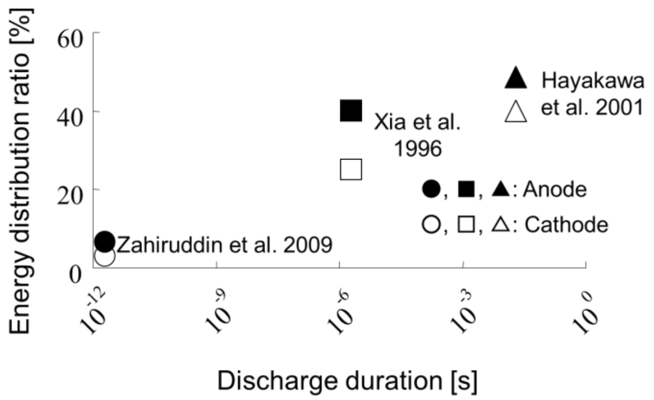


Figure 3: Energy distribution into anode and cathode

[1] Xia H., Kunieda M., Nishiwaki N., 1996, Removal Amount Difference between Anode and Cathode in EDM Process, IJEM, 1, 45-52.

[2] Xia H., 1995, Study on Factors Affecting Electrode Wear Ratio and Improvement of Machining Characteristics in EDM Process, Dissertation of Tokyo University of Agriculture and Technology (in Japanese).

[3] Xia H., Hashimoto, H., Kunieda M., Nishiwaki N., 1996, Measurement of Energy Distribution in Continuous EDM Process, J. of JSPE, 62, 8, 1141-1145 (in Japanese).

[4] Hayakawa, S., Yuzawa, M., Kunieda, M., Nishiwaki, N., 2001, Time Variation and Mechanism of Determining Power Distribution in Electrodes during EDM Process, IJEM, 6, 19-26.

[5] Zahiruddin M, Kunieda, M., 2009, Energy Distribution into Micro EDM Electrodes, Proc. the 5th Int'l Conf on Leading Edge Manufacturing in 21st Century (LEM21), 835-840.