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TECHNOLOGICAL, PRODUCTIVE AND ECONOMIC CHARACTERISATION OF ELECTROEROSION

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ABSTRACT

The paper present an analyse for the industrial applications of electroerosion machining. The main considerations was obtaned in the field of special tools manufacturing, like: forging dies, injection moulds of polymers, extrusion dies, deep drawing dies. The economic effects are studied to determine the optimum solutions about the choise and using of the technological equipment for the electroerosion process.

1. Introduction

Available electroerosion technology data provides mainly a guide to conditions for certain parameters. Is the paradoxal situation which electroerosion particularly: in the laboratory, specific tests under controlled and largely repeatable conditions, and with a standardized electrode geometry are carried out yielding results satisfying to the researcher and admittedly of some value in such terms.

But in practice such convenient conditions rarely obtain. The task itself is often intrinsically fairly complex and the operator adds his own influence by his response to changing conditions.

2. Electroerosion operation times

The applications and their basic data are summarized in table 1. We can resume, before beginning, two facts [1], [4]:

F1. The material removal rates are average values, because during electroerosion machining of 3D forms eroded area can change very considerably and with it the maximum current. It follows that the average material removal rate will be lower than that associated instantaneously with the maximum area concerned.

F2. In such industrial circumstances, characterized by complex geometry of the 3D surfaces and the gap, instantaneously metal removal rate is lower than that associated with simple forms of standard tests.

A graphical comparation of total operation times, roughing and finishing, is shown in figure 1. A much simpler graph is represented in figure 2, resulting from plotting the volume material rate in roughing operation against material volume eroded. There appear to be three characteristic regions [2]:

First region - extrusion dies, in particular, volume removal rate is fairly insensitive to material eroded, and this is a function of the use of a single operation and electrode during which the final finish must be conferred at the side wall.

Second region - the majority of medium sized forging, casting and plastics tools; here it is evident that the larger the volume to be eroded the greater scope is there for higher utilisable generator power, and this leads to a worthwhile increase in removal rate.

Third region - indicate the existence of an ultimately limiting achievable material removal rate somewhere in the range 20 to 30 mm^3/s, irrespective of the size of the task and the machine (generator) power available.

3. Electroerosion machine rating and utilization

Illustration of manufacturing economics with a range of electroerosion machines on a range of job sizes is shown in figure 3. Volume eroded (job size) increases, progressively larger machines with increased maximum current available are used, but the utilusable current is related to electrode active area.

The calculation has been performed in effect for the roughing operation only, partly because it is this which sets higher power capacity on a larger jobs, and also since finishing requires a somewhat arbitrary decision on finishing allowance. The cost of electroerosion machining increases in general with the size of the job (volume eroded).

Figure 4 shown that the curve of roughing operation time tends to level out where the proportional increase in material removal rate is evident (in figure 2), but is increasing with volume eroded elsewhere.

Table 1 (abstract from [1], [4])

					ROUGHING			FINISHING		
Part type	**Product**	**Part material**	**Volume eroded x 10^{-3} [mm^3]**	**Max. current [A]**	**Electrode material**	**Oper. time [h]**	**Removal rate [mm^3/s]**	**Electrode material**	**Oper. time [h]**	**Surface finish [μm]**
Extrusion dies	Alum. extrusion	YT 5	3,3	30	copper	1,5	0,59	-	-	2,7
Press tool dies	Sheet metal pressing	C120	4,3	30	graphite	1,1	1,08	graphite	3,2	1,8
	Sheet metal pressing	C120	18	60	copper	2,75	-	copper-tungsten	4,7	2,0
	Sheet metal pressing	T29	0,75	30	copper	1,27	-	copper	1,8	1,25
Forging dies	Hammer head	VCW85	70,0	120	graphite	2,0	9,4	graphite	0,7	3,6
	Scissors	VCW85	6,1	50	copper	2,5	0,8	copper	1,58	1,6
Plastic moulds	Yacht toy	Die steel	12,3	90	graphite	0,63	5,2	copper	1,75	2,5
	Shoe heel	Die steel	35,2	50	graphite	1,8	3,9	graphite	1,2	3,1

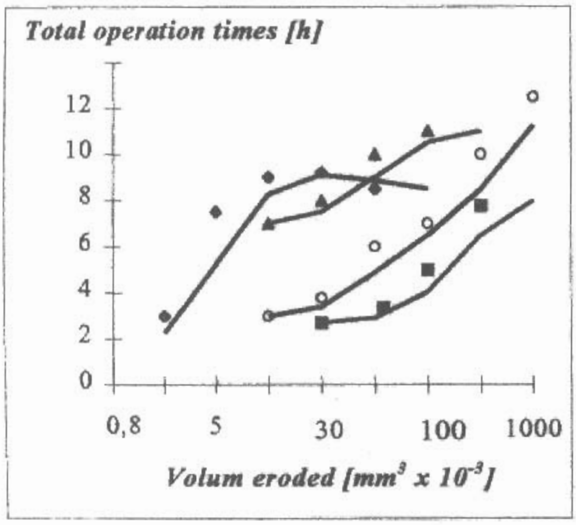

Figure 1. Total operation time [4]

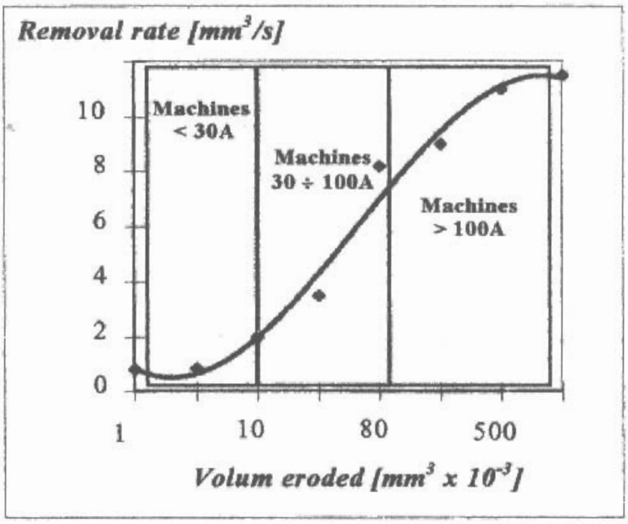

Figure 2. Removal rate and machine power [2]

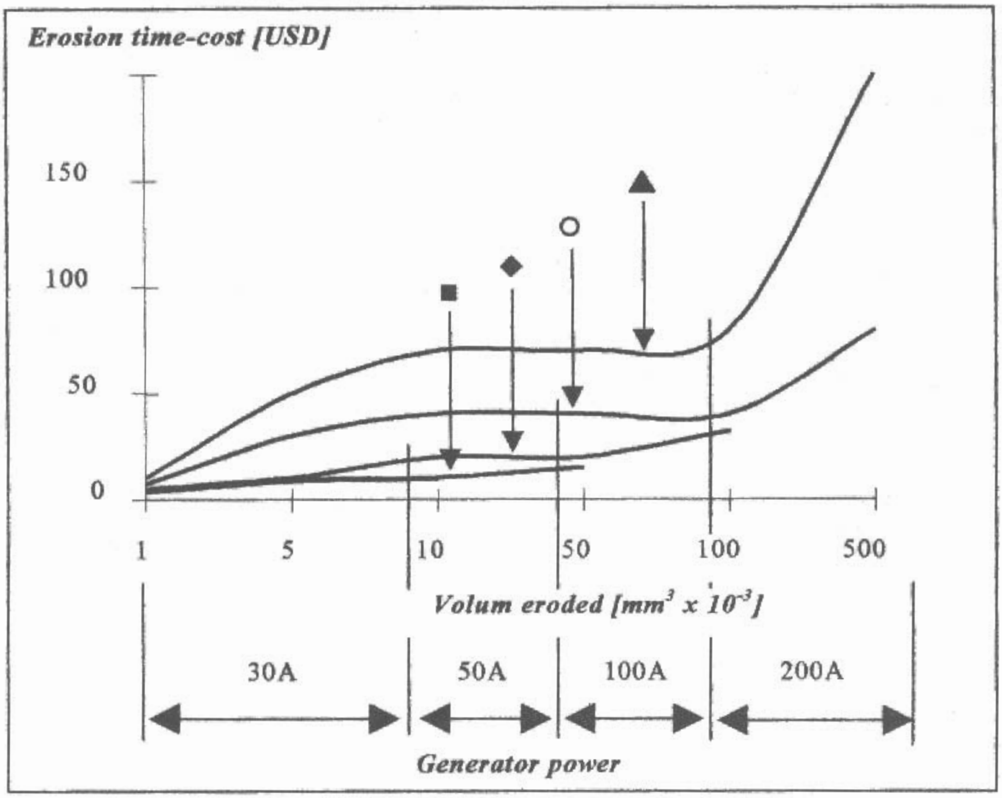

Figure 3. Erosion time-cost [2]

The used simbols:

- ◆ Forging dies
- O Plastic moulds
- ■ Extrusion dies
- ▲ Press tool dies

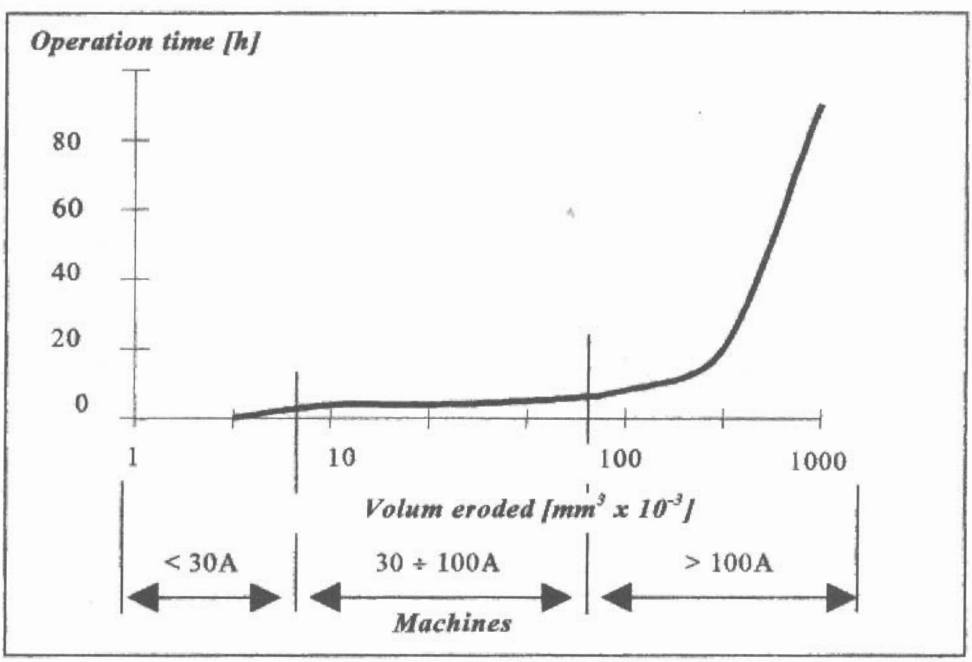

Figure 4. Operation time [2]

The situation may be summarized as follows:

- The composite curve illustrates the relationship between machine size (power) and job size which might reasonably be employed, and indeed is drawn from actual industrial applications of electroerosion process over a wide range of tooling manufacture.

- The rightward curve extensions under the "max. generator power lines" represents the economic consequences of using small (under-capacity) machines; in this case the operation times are expectedly longer.

- The leftward curve extensions represents the use of too large (over-capacity) machines; operation times cannot be significantly reduced however because the job size restricts the power that may be used.

4. Concluding remarks

Admittedly, material removal rate on some die materials in the unhardened state may be greater by conventional methods than by electroerosion, but due recognition must be given to the technological advantages of electroerosion method in machining of hard materials, and materials the hardened state, thus avoiding distortion after heat treatment [4].

Thus the technological, productive and economic characteristics of electroerosion are in a particular class which is many respects apart from those of conventional methods. In combination therefore, and judiciously and effectively used, these factors both underline and justify the considerable and beneficial use in modern tooling manufacture of electroerosion machines and techniques of many different kinds.

References

[1]. **Dorf, C. R., Kusiac, A.** *Handbook of design, manufacturing and automation.* A Wiley – Interscience Publication, New York, 1994

[2]. **Carter, G. A., Uameson, C.** *Choise of EDM tooling.* EDM Digest, vol. 3, no. 2, page 18-24, 1991

[3]. **Gavrilas I., Marinescu N.I.** *Prelucrari neconventionale in constructia de masini.* Editura Tehnica, Bucuresti, vol. 1, 1991

[4]. **Tabacaru, V.** *Technical reports of industrial contracts 1998-2000.* DITDP Scientific Programm, 2000

Caracterizarea tehnologică, productivă şi economică a prelucrării prin electroeroziune

Rezumat

Lucrarea prezintă o serie de aplicaţii industriale ale prelucrării prin eroziune electrică, focalizate în domeniul fabricaţiei sculelor speciale, cum sunt: matriţe pentru forjare, forme de injectare a maselor plastice, matriţe pentru extrudare, matriţe pentru presare la rece a tablelor. Sunt analizate implicaţiile economice ale procedeului, care influenţează alegerea şi utilizarea în condiţii optime a echipamentelor tehnologice de prelucrare prin eroziune electrică.

Characterisation technologique, productique et économique de la fabrication par électroérosion

Resumé

L'étude presente une annalyse detaillée des applications industrielles du processus d'électroérosion, concentrés dans le domâine de fabrication des outtils spéciales: forgeage, injection des polymeres, éxtrusion, mise en forme des tolles. L'annalyse contienne un pacquet d'informations économiques et téchnologiques qui ont des fortes influences sur l'utilisation optimale des équipements téchnologiques d'usinage par électroérosion.