© INTERNATIONAL JOURNAL FOR RESEARCH PUBLICATION & SEMINAR
ISSN: 2278-6848 | Volume: 07 Issue: 09 | October – December 2016
Paper is available at www.jrps.in | Email : info@jrps.in

An impression of technology and investigation of built-up Electrical discharge machining (EDM)

Deepak,
Department of Automobile Engineering,
GBPIT, Govt. Of NCT of Delhi, DTTE (INDIA)
E-mail: ali10.sharma @gmail.com

Abstract: - Electrical discharge machining (EDM) is unique of the initial non-traditional machining methods, based on thermoelectric initiative among the work piece and an electrode. In this procedure, the physical is removed electro thermally by a categorization of uninterrupted discrete acquittals between binary electrically conductive objects, i.e. the electrode and the work piece. The performance of the process, to a large extent, depends on the material, proposal and manufacturing method of the electrodes. Electrode design and method of its manufacturing also effect on the cost of electrode. Researchers have explored a number of ways to improve electrode design and devised various ways of manufacturing. The paper reports a review on the research relating to EDM electrode design and its manufacturing for improving and optimizing performance measures and reducing time and cost of manufacturing. The finishing part of the paper deliberates these progresses and frameworks the trends for future research work. **Keywords:** EDM, Process parameters, MRR, Electrode design, manufacturing

1. Introduction: - Electrical discharge machining is mainly a nonconventional material removal procedure. This procedure is broadly recycled to produce dies, punches and molds, final parts for aerospace and automotive industry and surgical components [1].This process can be successfully employed to machine electrically conductive work pieces irrespective of their hardness, shape and toughness [2-4]. During EDM process, the electrode shape is mirrored in the work piece. The electrode dimensions are determined in such a way that spark gap between the surface to be generated and electrode is maintained. Higher gap is required for higher removal rate but also higher gap results in poor surface quality. The performance of the EDM process is highly dependent on the material and the design of the electrodes. The electrode has two parts, i.e. electrode tool and holder. Both these parts are often designed and manufactured into single piece. The simple electrodes are normally manufactured by conventional cutting methods, but machining, casting, electroforming or metal spraying may produce complicated shape electrodes. In die-sinking electrical discharge machining process, in general, either fixed electrodes are used to produce die cavities or a rotary device works in

© INTERNATIONAL JOURNAL FOR RESEARCH PUBLICATION & SEMINAR
ISSN: 2278-6848 | Volume: 07 Issue: 09 | October – December 2016
Paper is available at www.jrps.in | Email : info@jrps.in

conjunction with a CNC to control the electrode‘s path in various EDM profiling [5-7]. Manufacturing method of electrode also affects manufacturing time, cost and performance of EDM electrode. Electrode and the work piece In present day‘s scenario, EDM is used as a standard

2. Dissimilar features of electrode purpose:- Principles of electrode design the prime role of EDM tool is to convey the electrical pulse to allow erosion of work piece with little or no tool wear. Considerable effort has gone into the EDM tooling problem regarding inexpensive tool materials, ease of manufacture, rapid work piece erosion, coupled with low tool erosion etc [8, 9]. To improve machining efficiency, roughing, finishing and semi-finishing electrodes are used in EDM process. EDM is mostly employed in obtaining mould cavities, cylindrical hole machining and 3-dimensional cavity machining. In cylindrical hole machining, through holes and cavities are produced by electrodes of constant cross section. However, in 3-dimensional cavity machining any cavity is machined with one or more electrodes with varying cross section. The tool design procedure is approximately same for both the cases [10]. Ding et al. [11] have discussed basic principles of electrode design. Poluyanov [12] have classified EDM tools into three groups depending upon the value of area of projection of electrode on the workpiece plane. The workpiece plane is considered perpendicular to direction of tool feed. A systematic diagram for these three types of tool. Two major factors governing the tool design are material selection and electrode wear.

2.1.1 Physical variety for EDM electrode:- The selection of the most appropriate electrode material is a key decision in the process plan for any sinking EDM job. The important variables to be considered for selection of electrode material are material removal rate, tool wear rate, surface roughness, machinability and material cost. Properties of different electrode materials and their influence on EDM performance as well as on fabrication of electrodes have been summarized in EDM handbooks [13, 14, 15]. Electrode material should have the basic properties like electrical and thermal conductivity, a high melting temperature, low wear rate, and resistance to deformation during machining. Since electric current is ―cutting tool‖, in EDM, higher conductivity (or conversely, lower resistivity) promotes more efficient cutting. Drozda [16] explained that the tool electrode is responsible to transport the users.

2.1.2 Electrode wear in EDM: - The tool wear process is quite similar to the material removal mechanism as the tool and workpiece are considered as a set of electrodes in EDM [1]. EDM electrode wear may be categorized into four types- (a) Volumetric (b) Corner (c) End and (d) Side [10]. Corner wear directly influence shape of the cavity. Heaviest electrode wear occurs at the corners. Jeswani [17] have analyzed the electrode erosion by dimensional analysis. An empirical relation was developed relating the material eroded from tool electrode to the energy pulse, density, thermal conductivity, specific heat and latent heat of vaporization of electrode material. Crookall et al. [18] have explained the effect of debris concentration on erosion rate. They have reported that increased debris resulted in increased erosion. Also use of distilled water as dielectric results in lower erosion rates in comparison to kerosene as dielectric. Mohri et al. [19] have investigated the tool wear mechanism and claimed that tool wear is affected by the precipitation of carbon from the hydrocarbon dielectric on the electrode surface during. They also reported that the rapid wear on the electrode edge was due to the failure of carbon to precipitate at difficult-to-reach regions of the electrode tool. Dauw [20] has developed a geometrical simulation of EDM describing the development of electrode wear and part geometry. It was also considered as an off-line process planning technique as the simulation algorithm is largely based on MRR, TWR and spark gap.

2.2 Relation of electrode intention with EDM enactment procedures: - Majority of researchers use material removal rate (MRR), tool wear rate (TWR) and surface roughness (SR) as performance indices. Electrode design affects the spark gap between EDM electrodes. Spark gap differs for different electrode geometries and also for different surface finish condition required. Higher spark gap results in higher voltage setting and improved flushing conditions resulting in higher MRR and rough surface. Flushing condition may also be improved by suitable electrode design. MRR is highly affected by types of dielectric and method of flushing [21]. Flushing is useful to remove debris from discharge zone even if it is difficult to avoid concentration gradient and inaccuracy [22, 23]. Better flushing conditions result in both increases in material removal rate and tool wear. Better flushing conditions is reported by introducing electrode rotation, tube electrode design and electrode with eccentric hole

3. Different aspects of electrode manufacturing:-used extensively in the machining of dies and moulds with hardened material. Generally, the cost and time consumption in the die and mould machining by EDM is the manufacturing of electrodes, which can account for over 50% of the total machining cost [24]. The cost of manufacturing electrodes is generally determined by the complexity of the geometry and the accuracy demanded. The electrodes for electrical discharge machining are generally fabricated using conventional machining methods. Uniformly dimensioned electrodes are cheaper to produce. For complex three dimensional shapes, machining, casting, electro-forming or metal spraying may produce electrodes. Fabrication of electrodes using rapid prototyping (RP) technology can also reduce the cost of producing electrodes with complex geometry. Research and development work in EDM electrode [25]

3.1 Electrode built-up using manufacture and machining:- These are conventional techniques of EDM electrode manufacturing. Casting is used for Zn based die casting alloy, Al alloys and Zn-Sn alloys [26]. However, cast electrodes have various

© INTERNATIONAL JOURNAL FOR RESEARCH PUBLICATION & SEMINAR
ISSN: 2278-6848 | Volume: 07 Issue: 09 | October – December 2016
Paper is available at www.jrps.in | Email : info@jrps.in

defects like blowholes, mismatching and micro cracks. Electrodes of copper and its alloys can be machined by using conventional machines [27]. In United States, high speed machining of graphite has become an increasingly popular solution. Application of these conventional techniques is limited due to complex cavities.

4. Observations and future trends The independent of the assessment object has been expected to report the work approved available by various researchers in the field of EDM electrode enterprise and built-up, and to connection the gap between the untouched areas. After decorative inspection of the published work, the following remarks appear from the current issued work.

• Most of the published work on EDM tool intention relays to parametric optimization, taming recital procedures and variety of suitable work-tool border. There is not much published work on EDM electrode design.

• In addition, published works in tool design include a few materials like copper and its alloys, graphite etc. Use of new materials like cermets which has low tool wear rate, high corrosion resistance and reasonably good conductivity has not been sufficiently investigated.

• Generally, tool makers use thumb rule or trial and error method for EDM tool design. Therefore, scientific investigation of design of circular as well as non circular electrodes is identified as an important area of research. Results of investigations may be extended for fabrication of tools with complex cavities.

• Like material removal mechanism, electrode wear mechanism (ERM) is also a complex phenomenon. Simplified assumptions and approaches in theoretical modeling, have led to large disagreement with results. Therefore, there is no sound theoretical basis for selecting a suitable tool material and design for a work material. Selection of suitable work-tool interface is mainly based on empirical results. .

• Application of plate, frame and ball ended cylindrical tool design seems to have a lot of potential for commercial applications. Their applications depend upon exploitation of CNC EMD capabilities allowing servo controlled tool movement along four axes. However, market survey shows that these capabilities are not fully being exploited by toolmakers. The reason for the same needs to be explored and thoroughly investigated.

• Even in 3D form tools, not much published work is available corresponding to use of different tool cross-sectional geometries like rectangular, triangular etc. on performance measure like MRR, EWR etc. Therefore, effect of different tool geometries on MRR, EWR, surface roughness etc. has to be explored for more work materials.

• In case of non circular electrode design, effects of profile parameters of a particular profile (like inscribed angle in case of triangular electrode) on performance measures of EDM process are yet to be investigated sufficiently.

- Hollow tube and eccentric drilled holes type electrodes are reported to have a positive impact on MRR due to improved flushing conditions. Such designs need investigations for more work materials to evaluate their case to case effects.

- Multi spark EDM and multi electrode EDM are relatively new techniques for MRR improvement and are still under experimental stage. More empirical validation using different workpiece materials is required before the method is recommended for commercial applications.
- Although EDM electrodes formed by powder metallurgy route is a recommended alternative method for electrode manufacturing due to ease of production and control of properties but there is limited published work on investigating performance of such electrodes. Most of the published work relates to electrode formed by conventional techniques probably because of their easy availability.

- Although extensive research work has been performed on variations of rapid tooling electrodes but still they do not meet desirable standards for use as an alternative to conventional CNC or high speed machining electrodes. This is due to evident disadvantages like poor surface roughness.

5. Summary Intention and built-up:- of electrode play an important role in EDM technology. The present review paper reports research and development work carried out by various researchers in the same field. After elaborate scrutiny of the published work, future direction for the EDM research have been indicated as a novel contribution to the archival literature. List of abbreviations EDM: Electrical Discharge Machining MRR: Material Removal Rate CNC: Computed Numerically Controlled CAD/CAM: Computer Aided Design/ Computer Aided Manufacturing TWR: Tool Wear Rate SR: Surface Roughness PM: Powder Metallurgy RP: Rapid Prototyping RT: Rapid Tooling.

List of abbreviations:-

EDM:	Electrical Discharge Machining
MRR:	Material Removal Rate
CNC:	Computed Numerically Controlled
CAD:	Computer Aided Design
TWR:	Tool Wear Rate
SR:	Surface Roughness
PM:	Powder Metallurgy
RP:	Rapid Prototyping
RT:	Rapid Tooling

© INTERNATIONAL JOURNAL FOR RESEARCH PUBLICATION & SEMINAR
ISSN: 2278-6848 | Volume: 07 Issue: 09 | October – December 2016
Paper is available at www.jrps.in | Email : info@jrps.in

References:-

[1]. Ho KH, Newman ST (2003) State of the art electrical discharge machining (EDM). Int J Mach Tools Manuf 43: 1287–1300.

[2]. Kansal HK, Singh S, Kumar P (2007) Technology and research developments in powder mixed electric discharge machining (PMEDM). J Mater Process Technol 184:32–41.

[3]. Abu Zeid OA (1997) On the effect of electro-discharge machining parameters on the fatigue life of AISI D6 tool steel. J Mater Process Technol 68 (1): 27–32.

[4]. Ramasawmy H, Blunt L (2004) Effect of EDM process parameters on 3D surface topography. J Mater Process Technol 148:155–164.

[5]. Yan BH, Wang CC, Liu WD, Huang FY (2000) Machining characteristics of Al2O3/6061Al composite using rotary EDM with a disk like electrode. Int J Adv Manuf Technol 16(5): 322–333.

[6].Soni JS, Chakraverti G. (1994) Machining characteristics of titanium with rotary electro-discharge Machining. Wear 171: 51– 58.

[7]. Don, K.S. (1994) Electro discharge machining. Fu-Wen publish Co, p 40.

[8]. Gough PJC (1985) Electrode manufacturing: Conventional and new techniques. Proceedings of the First Electrical Machinery Symposium (EM85), Birmingham, UK :64–81.

[9]. Carter, GA, Jergas I (1983) Choice of electrical discharge machining tooling. E.C. Jameson (Ed.), Methods and Applications, Society of Manufacturing Engineers, Dearborn, MI, 1983: 57– 61.

[10]. HMT (1991) Production Technology. Tata McGraw Hill.

[11]. Ding XM, Fuh JYH, Lee KS (2002) Computer aided EDM electrode design. Computers and Industrial Engineering 42: 259-269.

[12]. Poluyanov VS (1995) On effects of electrode-tool shape on optimum electrical conditions of EDM roughing of cavities and holes. Proceedings of International Symposium for electro machining (ISEM-11), Lausanne, Switzerland: 191-200.

[13]. Machining Data Handbook (1980) 3rd Edition, Vol. 2, Machinability Data Center, Ohio, Section 11, 10.

[14]. Guide to Material Engineering Data and Information (1986) ASM International metals Park, Ohio.

[15]. Roger Kern (2008) Sinker electrode material selection. EDM Today, July/August 2008 Issue

[16]. Drozda T J (1998) Tool and Manufacturing Engineers Handbook: Machining, USA: Society of Mechanical Engineers, Vol.5.

[17]. Jeswani ML (1979) Dimensional analysis of tool wear in electrical discharge machining. Wear, 55: 153-161.

[18]. Crookall JR (1985) Basic factors in EDM operators with shaped electrodes. International Journal of machine tool design research: 491-498.

[19]. Mohri N, Suzuki M, Furuya M, Saito N (1995) Electrode wear process in electrical discharge machining. Ann. CIRP 44 (1):165–168.

[20]. Dauw D (1998) Geometrical simulation of the EDM die-sinking process. Ann. CIRP 37 (1): 191- 196.

[21]. Wong YS, Lim LC, Lee LC (1995) Effect of flushing on electrodischarge machined surfaces. J Mater Process Technol 48:299–305.

[22]. De Bruyn HE (1970) Some aspects of the influence of gap flushing on the accuracy in finishing by spark erosion. Ann. CIRP 18: 147-151.

[23]. Masuzawa T, Cui X, Taniguchi N (1992) Improved jet flushing for EDM. Ann. CIRP 41/1: 239-242.

[24] . Li L, Wong YS, Fuh JYH, Lu L (2001) EDM performance of TiC/ copper-based sintered electrodes. Materials & Design 22:669–678.

[25]. Mahajan KR, Knoppers GE, Oosterling, JAJ, Van Luttervelt, CA (2004) Knowledge based design of EDM electrodes for mould cavities pre-machined by high-speed milling. J Mater Process Technol149:71–76.

[26]. Ghosh A, Mallik AK, (1985) Manufacturing Science. East West Press Private Limited.

[27]. Machinery Hand Book (2000) 26th Edition, Industrial Press Inc 200, Madison Avenue, New York-10016- 4078.