International Conference on Inter Disciplinary Research in Engineering and Technology 2016
[ICIDRET 2016]

ISBN	978-81-929866-0-9	**VOL**	01
Website	icidret.in	**eMail**	icidret@asdf.res.in
Received	23-December-2015	**Accepted**	30-December-2015
Article ID	ICIDRET016	**eAID**	ICIDRET.2016.016

Possibility of LENR Occurring in Electric Arc-Plasma: Preliminary Investigation of Anomalous Heat Generation during Underwater Arcing using Carbon Electrodes

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Abstract: *The author and his students have investigated anomalous heat generation during carbon arcing done under saline water solutions using carbon electrodes. Energy balance calculations, indicate a marginal excess energy of up to 50 % with MS electrodes while with carbon electrodes output to input energy ratios are found to be as high as a factor of eight indicating excess heat up to 700%. We think that the anomalous excess energy could be due to some type of Low Energy Nuclear Reactions (LENR) but the nature of these reactions have not been studied by us so far. The carbon-electrode arc results on heat-accounting corroborate the mass-spectroscopic findings reported by BARC, Texas A &M University and other groups.*

Keywords*:* LENR, BARC, Carbon Electrodes.

INTRODUCTION

Nuclear-Fusion is a phenomenon which occurs at extremely high-temperatures of the order of a few million degrees Celsius, as in the core of Sun. Arc-welding is a fabrication-technique in which the metal pieces are joined by melting it with the heat of the electric-arc having a temperature of the order of a few thousand degrees Celsius. Quite obviously it seems that there is no link of nuclear-fusion in arc-welding or in electric-arc. The *author,* however, in-view-of various reasons such as the appearance of very-strong & intense bright-arc in welding as well as in fatally-dangerous lightning-arc, suspects a possibility of nuclear-fusion (LENR) occurring within the arc. Note that the electric-arc is nothing but plasma i.e., hot ionized gases, so likelihood of nuclear-fusion (LENR) of the positive-ions within the arc cannot be ruled out.

Arc-welding is employed routinely in industrial fabrication processes during which metal pieces are joined permanently following local melting caused by the intense heat of the electrically generated arcs. While the temperature produced during conventional industrial arc welding is quite adequate to melt metal samples, it certainly seems insufficient to cause nuclear (hot) fusion reactions. Nevertheless, in view of the growing number of reports in LENR literature that nuclear reactions have been observed in a variety of experimental configurations, it was decided to investigate the possible generation of anomalous heat during underwater arcing. Since in normal arcing in air, heat-balance accounting is quite difficult, it was decided to conduct underwater arcing experiments, wherein some heat produced (except the radiation-heat going-out) would be captured by the water resulting in heating and vaporization of the water, thereby enabling establishment of overall heat balance. The author is not aware of any such previous-studies carried out to correlate the heat generation during arcing with the known input electrical energy.

The objective of this research-report is to tell that there exists a possibility of Low-Energy Nuclear-Reaction (LENR) occurring during arc-welding or in electric-arcing; and if it is so, it would open a new possibility of utilizing otherwise-difficult nuclear-fusion for energy-production.

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Underwater Arcing Experiments

The arcing experiments were conducted in Amity School of Engineering & Technology of Amity University (Lucknow, India) with the help of B.Tech. Students under the author's supervision [1]. In Carbon-Electrode-Arc (CEA) experiments the central carbon-rods of used flashlight torch-cells were taken-out and used. During the first test the calibrated beaker was filled with 1% saline water in which pair of Carbon electrodes were submerged with tips separated with very little distance (stand-off distance). Figures 1 depict the CEA experimental arrangements, the details of the experiments are given in Table 1 and its heat accounting in Table-2.

Mostly the arc was discontinuous and from video- clippings of the experiments, arc-stability factor f indicating the fraction of arc-duration of the experiment-time (t) was estimated. The arc-diameter was also observed from video-clippings & still-photographs (Figs 1 & 2), the arc-diameter seems to be much higher where d = 3 mm is taken for the DC-supply (Low-Wattage) experiments, for calculating arc's surface-area $A = 4\pi r^2 = \pi d^2$ for radiation-heat calculation in Table-2. Arc-temperature T, usually the welding arc temperature is reported in literature as 6000°K which is taken in the experiment of year 2015; in the subsequent experiments when the encouraging-results in the year 2011 were coming-up, a lower value of arc-temperature of 5000 °K was taken. Actual arc-temperature can be found (though not done here) using optical-pyrometer much easier than with thermocouple, however, its intense illumination does indicate its temperature.

The initial volume of saline solution charged in the tank was 1 liter in most cases. In the carbon-rod arcing runs, however, the applied voltage was only 12 Volt from DC-battery and the arcing current was 8 amps. Thus the input power was less than KW and so the arcing could be sustained for 5 to 15 mins. Table-1 summarizes the experimental parameters. It may be noted that in all the runs except the first, the quantity of water lost due to evaporation was hardly 10 to 15 grams which is less than a couple of percent of total tank water volume.

Calorimetric Analysis of Heat Balance

Table-2 summarizes the details of heat balance computations. The total Energy input into the system (E_{in}) during the duration of the experiment is calculated as E_{in} == V*I*t. It is assumed that current is always flowing during the experimental-runs, even when there is no visible-arc, especially in view of continuous electrolysis.

The total heat Energy generated and leading to heating of the water designated as E_{out} comprises of the following four components:

- 'Sensible Heat'(E_s) utilization which results in increase of water-temperature over and above the initial water-temperature at the time of commencement of arcing.
- Heat used-up in evaporation of water {involving 'latent heat'(El) of evaporation}.
- Heat produced in 'radiation processes'(E_r) only during the arc-visibility incorporating the arc-stability-factor (f). However, only a small-part (E_a) of the radiation-heat (E_r) is absorbed (because of very-high light-transmissibility of water) in the water assisting in its heating, while remaining heat ($E_r - E_a$) is lost outside as (visible & invisible) radiation.
- Energy consumed in 'electrolysis' (E_e) of water (generation of hydrogen and oxygen), however this would be small.
- The total heat-output E_{out} is the sum of 'heat utilized' (for heating E_s, evaporation E_l & electrolysis E_e) plus radiation 'lost-heat' Er-Ea. Hence, the total heat-output $E_{out} = E_s + E_l + (E_r - E_a) + E_e = E_s + E_l + E_r + (E_e - E_a)$. Note that both E_e & E_a are small, the difference would be smaller (can be assumed as tending to zero, especially in absence of good/reliable information about E_e & E_a). Hence, $E_{out} \approx E_s + E_l + E_r$ as done in Table-2
- For sensible-heat calculation $[M_1.s.(T_2-T_1)]$, specific-heat s = 1 x 4.18 Joule/gram/ °C; for latent-heat calculation [m.L], latent heat of steam-vaporization L = 536 x 4.18 Joule/gram and for radiation-heat calculation $[\sigma.A.\varepsilon.T^4.t.f)]$, arc-emissivity $\varepsilon = 1$, $\sigma = 5.67 \times 10^{-8}$ W/m^2/K^4 used; (see Tables 1 & 2).
- It may be noted that 'heating of the container' and 'convection loss' are completely neglected, its accounting would further increase the excess-heat. The CEA experiments (Fig.1) were conducted in glass-beaker. Although there was no arrangement of 'stirring' the water, but boiling-water near the electrode-tip causes self-stirring action. Since it is preliminary-investigation for anomalous-heat in electric-arcing, calibration was not done. The experiments were crude, but it does indicate a positive excess-heat (average ~ 500%) from a pessimistic-value of 5% to optimistic-value of 800% roughly.

Knowing the mass of water lost due to evaporation and the temperature rise of the balance water in the tank we could make a rough Estimate of the total energy dissipated in the tank, assuming that all the water was lost by evaporation using up 540 cals per gram. However, we concede that there may have been an unknown quantum of water which was carried away as droplets – as "wet steam" so to say! (We are aware that similar critical questions were raised regarding the calorimetry adopted by Andrea Rossi with reference to his 10 KW demo of Jan 14th 2011). However, dryness-fraction of steam is usually around 0.95 meaning-by that wetness is only around 5%, thus it should not cause much error in latent-heat calculations. If Rossi's E-Cat reactor (boiler) is really true, the author suspects that there might be a deliberate use of 'electric-arcing' inside it.

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Results and Discussion

A rough calorimetric heat balance accounting in underwater welding experiment is done considering water heating, latent-heat of evaporation and visible radiation heat; convection heat losses if any are neglected. Initial experiments conducted in 2015, revealed that around 30% more heat is produced than the input electrical-energy! This indicates that there is indeed a possibility that a low-energy nuclear-reaction (LENR) that might be occurring within the arc. But exactly what nuclear-reactions could actually be occurring there, is yet to be investigated. But if any such nuclear-fusion occurs there, this would open a revolutionary vista for energy-production, say, through steam-generation via underwater arc-welding or electric-arcing.

Theoretically too, fusion of positive-ions in the electric-arc seems possible; since a new-found 'Gupta-Dinu Effect' [3] predicts that positive-charges would be attracted towards electric-current. In another paper [4] it is shown that the 'Gupta-Dinu Effect' could possibly explain 'how Coulomb repulsion is overcome' in cold-fusion (LENR).

Postscript:
The author later-on [5], during ICCF-16, came to know through Dr. M. Srinivasan (Chairman, organizing committee, ICCF-16) that: BARC and Texas A & M University have already reported (in J. of Fusion Technology, vol.26 in Nov.1994) possibility of nuclear-fusion in carbon-arc experiments and have reported [6,7] from mass-spectrographic analysis possible *synthesis of 'Iron' from 'carbon* & *oxygen' in the arc*. These experiments, in a way, support the possibility of nuclear-fusion in arc-welding.
The present author & his students too, later-on (in 2015) carried out [8] Carbon-Electrode-Arc (CEA) experiments (with 12 Volt battery driven DC-supply. The rough calorimetric heat-accounting therein (Tables -1& 2) indicates higher excess-heat (~ 700%) in the CEA-experiments.
Electric arcing or discharge between two terminals do *cause* LENR-*reactions (nuclear-transmutation)* is firmly Established, through the thorough-experimentation & mass-spectroscopic analysis, by Edward & Alex in the recent book named 'Cool Fusion' [9].

Conclusion

Electric-arc is basically plasma. The speculation of possibility of nuclear-fusion (LENR) in arc-welding indeed seems to be true. For better heat accounting carbon-electrode-arc experiments conducted give much higher (~ 700%) excess-heat, and further reinforce the claim for possibility of nuclear-fusion (LENR) in the electric-arc. Spectroscopic-analysis results of other researchers do support the claim of LENR in the electric-arc. Electric-arc could thus possibly be used for water-heating & steam-generation and hence for power-production with this simple but revolutionary proposal of extracting excess-heat of the electric-arc.

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Table – 1

Details of Carbon Electrode Arc (CEA) experiments done in year 2015 with DC power source

Experiment No.	Initial water-factor	Final water-	Initial water-	Final water-	Water vaporized	Current	Voltage	Time	Arc Stability

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f	Temp. T_1 °C	Temp T_2 °C	mass M_1 gram	mass M_2 gram	$m=M_1 - M2$ gram	I Amp	V Volt	t sec.	
CEA (2015)-DC supply-1	24	50	1000	986	14	8	12	900	0.70
CEA (2015)-DC supply-2	25	40	1000	988	12	8	12	480	0.70
CEA (2015)-DC supply-3	31	40	1000	990	10	8	12	360	0.60

Table – 2

Heat calculations / accounting of the experiments (details of which are shown in previous Table)

Experiment No. % ExcEss Heat [=100(Output-Input)/Input]	Input Energy V.I.t Joule	Sensible Heat $M_1.s.(T_2-T_1)$ Joule	Latent Heat m.L Joule	Radiation Heat $\sigma.A.\varepsilon.T^4.t.f$ Joule	Total Heat (=Output/Input) Output Joule	Heat Factor
CEA(2011)-DC supply-1	87 x10^3	108 x10^3	32 x10^3	629 x10^3	769 x10^3	8.84	784%
CEA(2011)-DC supply-2	46 x10^3	63 x10^3	27 x10^3	335 x10^3	425 x10^3	9.26	826%
CEA(2011)-DC supply-3	35 x10^3	38 x10^3	23 x10^3	216 x10^3	277 x10^3	7.91	691%

Fig.1 Carbon Electrode Arc (CEA) Experiment

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