Application of the electrohydraulic shock method for cleaning resins and resin-like contaminants from metal surfaces

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INTRODUCTION

The efficiency of industrial heat exchangers is greatly affected by various external and internal deposits, which is why it is necessary to clean the internal and external surfaces. Deposits are mainly of two types: hard (calcium, magnesium oxides, etc.) and sticky - resins, bitumen, etc., depending on the working conditions - temperature regimes or the type of working agent. During operation, as contaminants accumulate, the inner diameter of the pipe becomes too small and the required flow of working fluid cannot pass through it. During this study, the electro-hydraulic impact method was applied to clean deposits. This cleaning method is more efficient and more ecological compared to the chemical cleaning method, which is usually applied to the maintenance of heat exchangers.

RESEARCH QUESTION

- Is it possible to use an electrohydraulic impact to clean metal surfaces from various contaminants generated during the process?.

METHODOLOGY

A controlled high voltage (up to 30 kV) source was used to charge a 1 μF capacitor bank. The capacitor bank is discharged through electrodes in water by creating a shock wave and cavitation, both of which are involved in the cleaning. A stone-type contaminant was crushed, with the electrodes in front of each other and the part underneath; The resin contaminant was removed by using the same scheme or adhered to the part, with the part on one electrode and the other electrode above it.

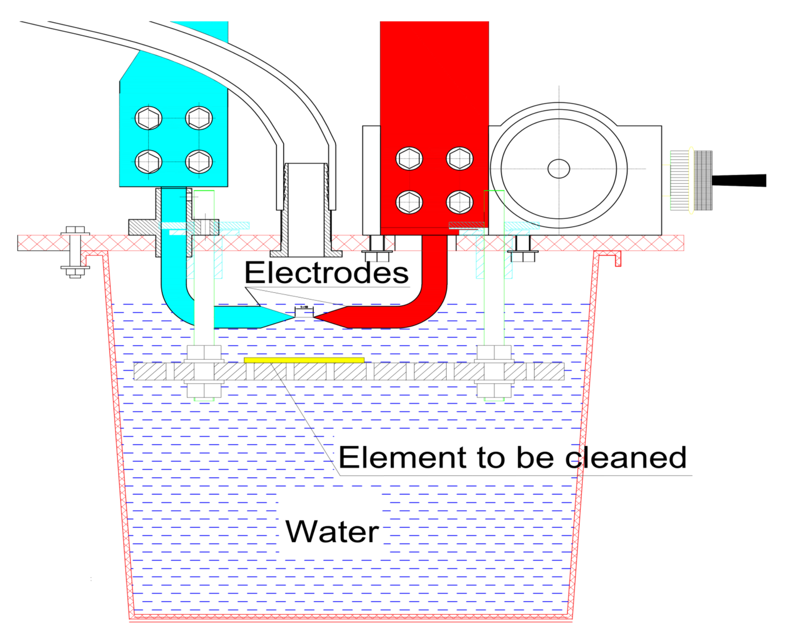

Figure (1): Schematic of the experimental bench with bend electrode configuration

Figure (2): Resin specimen before test

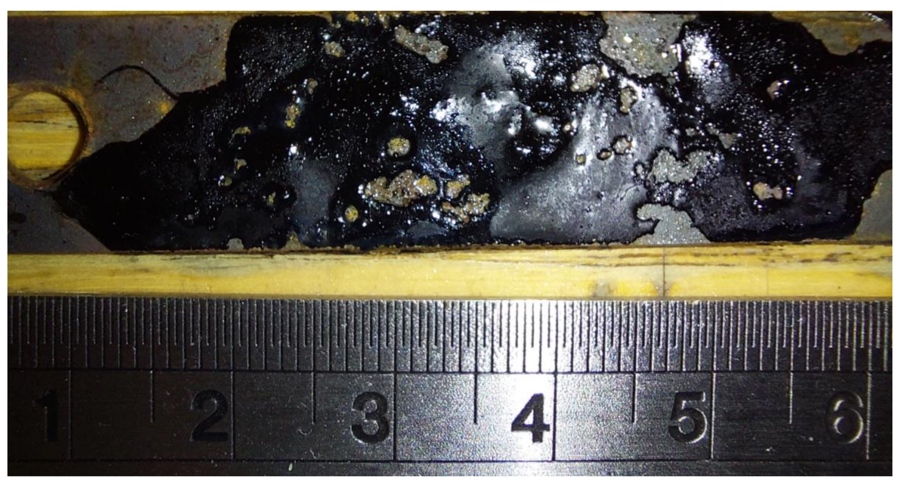

Figure (3): Resin specimen after test

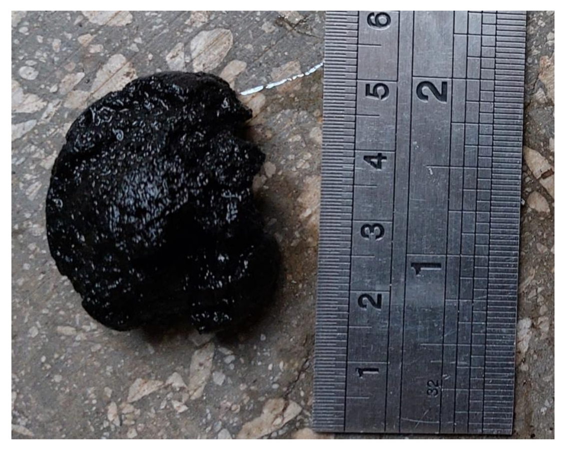

Figure (4): Solid specimen before test

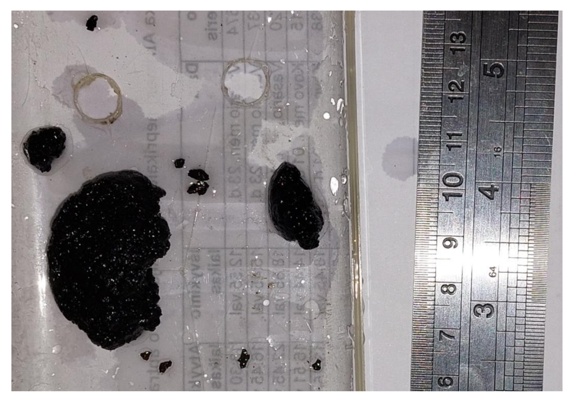

Figure (5): Solid specimen after test

RESULTS AND DISCUSSION

The solid deposits were exposed to a very low number of discrages and were successfully destroyed (Table 1). The data for the cleaning of the adhesive material over which the electrodes are located are given in Table 2. When the material to be cleaned is itself an electrode and the other electrode is above it, the data are given in Table 3. It can be seen that in this case the cleaning efficiency per discharge is higher.

Table 1. Data from experiments with bent electrodes (solid specimen)

Exp. No.	Mass of applied material before application, g	Mass of applied material after exposure, g	Number of discharges, pcs.	Voltage, kV	Stored energy, J	Mass removed, g	Mass removed per 1discharge, mg
1.	10,57	8,72	30	25,0 – 29,0	313 - 420	1,86	61,9

Table 2. Data from experiments with bent electrodes (resin specimen)

Exp. No.	Mass of applied material before application, g	Mass of applied material after exposure, g	Number of discharges, pcs.	Voltage, kV	Stored energy, J	Mass removed, g	Mass removed per 1discharge, mg
2.	0,39	0,35	200	27,5	378	0,04	0,20
3.	0,58	0,41	600	29,8	444	0,1626	0,27

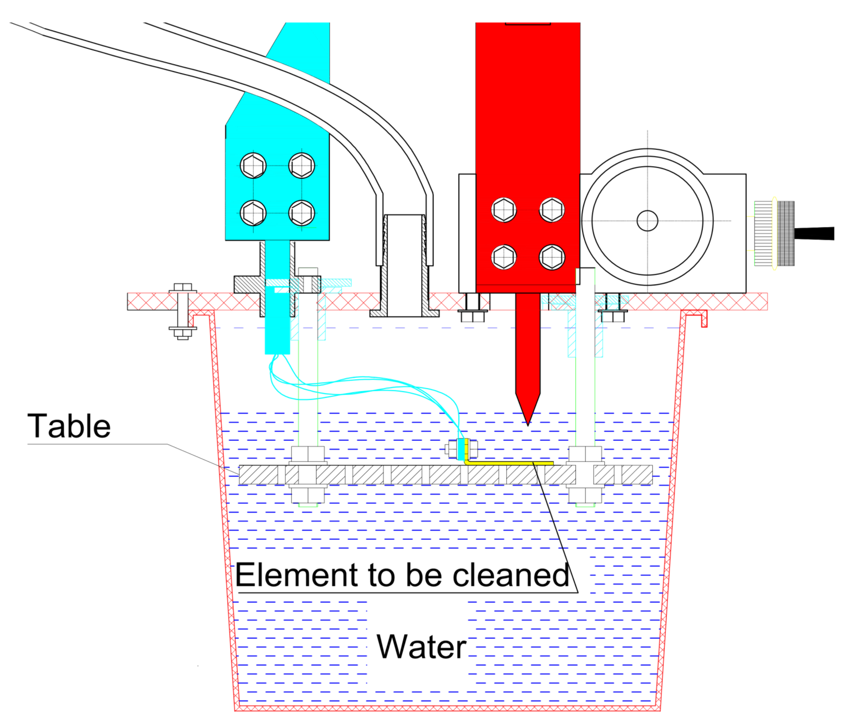

Figure (6): Schematic of the experimental bench with straight electrode configuration

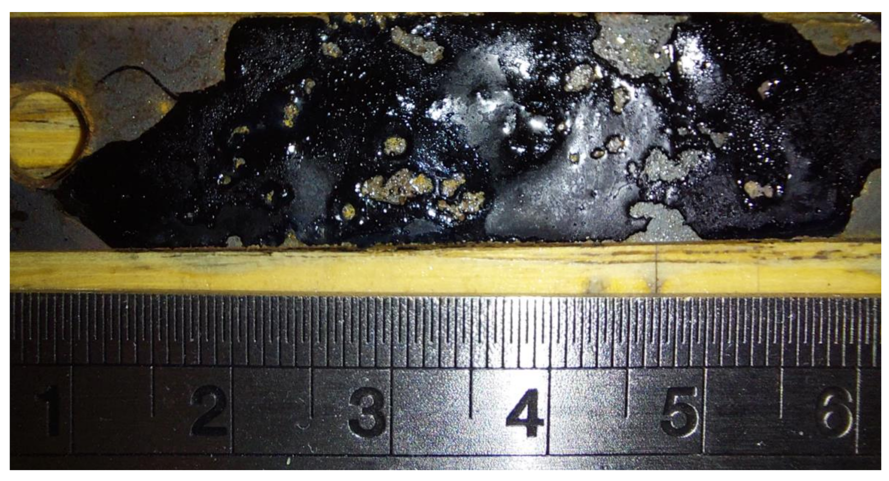

Figure (7): Sample before test with flat (positive) and straight electrodes

Figure (8): Sample after test with flat (positive) and straight electrodes

Table 3. Data from experiments with flat and straight electrodes (resin specimen)

Exp. No.	Flat electrode polarity	Mass of applied material before application, g	Mass of applied material after exposure, g	Number of discharges, pcs.	Voltage, kV	Stored energy, J	Mass removed, g	Mass removed per 1discharge, mg
4.	„+"	0,52	0,27	1100	28,5	406	0,25	0,23
5.	„-„	1,24	0,43	1250	28,5	406	0,82	0,65

CONCLUSION

The use of the electrohydraulic shock method is a suitable method for the cleaning of contaminated materials where the deposits are in a solid or sticky state. The effect of electrohydraulic shock on the cleaning of contaminated materials with sticky deposits depends on the arrangement of the electrodes. The application of electrohydraulic shock for the cleaning of contaminated materials with adhesive deposits is more effective with flat and straight electrodes, and the process is substantially more effective when the flat electrode has a negative polarity.

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