15:21:21 OCA PAD INITIATION - PROJECT HEADER INFORMATION 04/16/90

Active

Project #: A-8636 Cost share #: Rev #: 0
Center # : 24-6-R8636-000 Center shr #: OCA file #:
Work type : RES
Contract#: DTD 4/1/90 Mod #: Document : AGR
Prime #: Contract entity: GTRC

Subprojects ? : N
Main project #:

Project unit: EMSL-GTRI Unit code: 01.021.210
Project director(s):
PATEL G R EMSL-ESD (404)894-3635

Sponsor/division names: CAVERT WIRE / UNIONTOWN, PA
Sponsor/division codes: 202 / 090

Award period: 900401 to 901130 (performance) 901130 (reports)

Sponsor amount	New this change	Total to date
Contract value	25,755.00	25,755.00
Funded	25,755.00	25,755.00
Cost sharing amount		0.00

Does subcontracting plan apply ?: N

Title: INVESTIGATION OF ALTERNATE SURFACE MATERIAL TO REPLACE GALVANIZING FOR...

PROJECT ADMINISTRATION DATA

OCA contact: David B. Bridges 894-4820

Sponsor technical contact

WOLFORD SWIMMER
(412)438-4545

CAVERT WIRE CO.
P.O. BOX 1167
UNIONTOWN, PA 15401

Sponsor issuing office

WOLFORD SWIMMER

(412)438-4545

Security class (U,C,S,TS) : U
ONR resident rep. is ACO (Y/N): N
Defense priority rating : N/A
supplemental sheet
Equipment title vests with: Sponsor GIT
NONE PROPOSED
Administrative comments -
PROJECT INITIATION, TERMINATES 11/30/90 W/ FINAL RPT DUE AT THAT TIME;
ADVANCE PAYMENT IAO $6439 HAS BEEN REC'D;

GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION

NOTICE OF PROJECT CLOSEOUT

Closeout Notice Date 02/04/91

Project No. A-8636 Center No. 24-6-R8636-000

Project Director PATEL G R School/Lab MSTL

Sponsor CAVERT WIRE/UNIONTOWN, PA

Contract/Grant No. DTD 4/1/90 Contract Entity GTRC

Prime Contract No.

Title INVESTIGATION OF ALTERNATE SURFACE MATERIAL TO REPLACE GALVANIZING FOR...

Effective Completion Date 901212 (Performance) ______ (Reports)

Closeout Actions Required:	Y/N	Date Submitted
Final Invoice or Copy of Final Invoice	Y	
Final Report of Inventions and/or Subcontracts	N	
Government Property Inventory & Related Certificate	N	
Classified Material Certificate	N	
Release and Assignment	N	
Other	N	

Comments

Subproject Under Main Project No.

Continues Project No.

Distribution Required:

Project Director	Y
Administrative Network Representative	Y
GTRI Accounting/Grants and Contracts	Y
Procurement/Supply Services	Y
Research Property Managment	Y
Research Security Services	N
Reports Coordinator (OCA)	Y
GTRC	N
Project File	Y
Other	N
	N

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ATLANTA, GEORGIA 30332

GTRI

ALTERNATE COATING TECHNIQUES TO GALVANIZING FOR CAVERT WIRE COMPANY

Submitted by

Gautam R. Patel
Dr. Jan Gooch

Project A-8636

September 7, 1990

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INTRODUCTION

Objectives of this study are to obtain a suitable organic coating on the steel wire surface, to replace the galvanizing process and to use the organically coated wire suitable for bailing application.

Several techniques or processes have been considered to coat the steel wire surface with epoxy resin material. These processes are 1) dipping and 2) electrodeposition.

Several factors such as cost, pollution, etc., have been taken into consideration in selecting these processes.

CONCLUSIONS

1) Laboratory tests indicated that both the Dipping Process and the Electrodeposition Process should be applicable to obtain the desired epoxy coating on the steel wire surface.

2) Both the processes can be made to be continuous.

3) Selection of the process will depend on the size of the operation and the investment.

4) The Electrodeposition Process probably will be more expensive than the Dipping Process. The Electrodeposition Process, however, will give better control of the coating thickness than the Dipping Process and with less pollution.

5) The cost per pound to coat the coils will depend on the production and should be determined by the company personnel.

6) Both these processes are attractive since they are practically pollution free.

7) Epoxy coating is softer than the zinc coating. The speed at which the wire is fed through the machine is high. It is not known what effect the speed will have on the epoxy coated wire during the bailing operation.

DIPPING PROCESS

A flow chart summarizing the dipping process is shown in Figure 1. The process includes the following steps:

1) Pre-treatment
2) Coating
3) Curing
4) Cooling
5) Coiling

The process can be made semi-continuous or continuous and can coat one strand or several strands of wire simultaneously.

Pre-treatment

It is very important that the wire surface be free of rust or oxide. A pre-treatment consisting of lead bath, pickling and washing is recommended to ensure a rust-free surface. The lead bath should be kept at the liquidous temperature of lead.

Coating

The wire can be kept at room temperature or be kept at a certain specified temperature before entering the coating chamber. The size of the coating chamber will depend on the number of strands to be coated simultaneously. The coating solution consists of mixing an epoxy and a curing agent in a certain proportion diluted with a solvent such as toluene. The recommended coating solution is as follows:

epoxy/hardner	solvent
4:1 (ratio)	40% (dilution)

The wire surface to be coated is passed under the surface of a coating solution followed by drying in an oven or furnace. The coating solution is continuously stirred to minimize jelling.

Controlling parameters: The coating thickness can be controlled by passing the coated wire through 1) a wiper (felt cloth) or a die (specially designed) which can be installed at the exit of the coating chamber and 2) viscosity of the bath.

Curing Furnace

The coated wire is passed through the curing furnace. It is recommended that the curing temperature be kept at approximately 150°F. The size of the furnace will depend on the number of strands to be coated. Two to four minutes of curing time is preferred to completely cure the resin. Exposure of the solvent to the atmosphere should be minimized to recover the solvent.

Cooling Process

Soon after the curing process, the coated wire is passed through the water bath (to quench it), dried and then coiled.

FLOW CHART

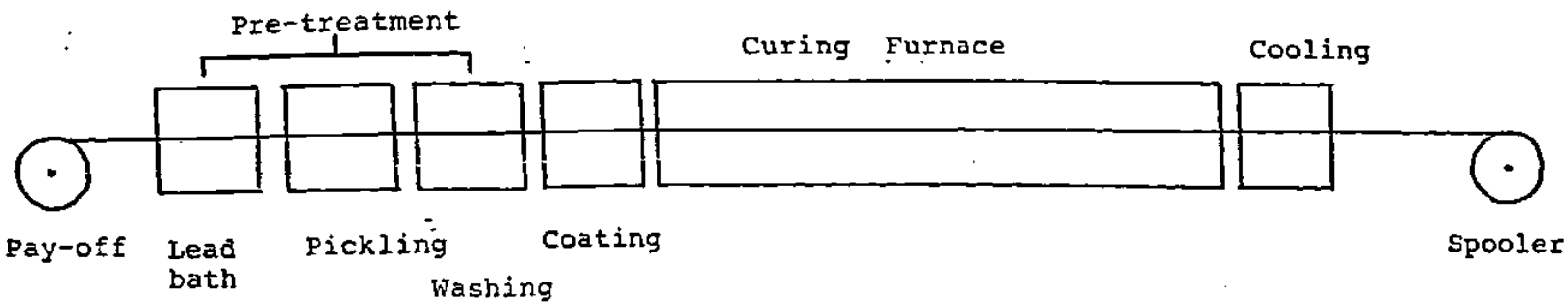

Figure 1: Schematic showing Dipping process.

ELECTRODEPOSITION PROCESS

In the electrodeposition of epoxy coating, the work piece is submerged in a water based bath of epoxy resin. The work piece is energized or voltage is applied and the epoxy is electrodeposited on the surface.

A flow chart summarizing the electrodeposition process is shown in Figure 2. The process includes the following steps:

1) Pre-treatment
2) Electrodeposition
3) Curing or baking
4) Washing

The process can be made continuous or batch type. In the latter case, several coils can be coated simultaneously depending on the size of the electrocoating tank.

Pretreatment

The use of proper pretreatment steps is essential for quality coating. The pretreatment steps suggested in the dipping process can also be followed in this process or can be a combination of steps in order to ensure that the surface is free of soil, oil, dust particles and oxide scale.

Electrodeposition

The process consists of an electrocoating tank which contains a water-based epoxy resin and a power source. In the batch type process, several coils can be loaded over the tank and dipped into the batch. In the continuous operation, several strands can be dipped into the tank simultaneously.

A cathodic process is recommended in which the part to be coated is negatively charged and the epoxy is positively charged. In this process, the oxygen and the water vapors are prevented from evolving at the interface which in turn protects the surface from corroding.

The recommended coating solution is as follows:

18 to 19% epoxy

1% solvent

80% water

The coating thickness is controlled by the applied voltage, temperature, time and the amount of solvent. The bath temperature is kept between 75°F to 90°F. The process is quick since only ½ mil to 1 mil coating thickness is required.

Curing or Baking

The coated work piece is cured in an oven between 400-450°F for approximately 90 seconds.

Rinsing and Drying

After the curing step, the work piece is rinsed or quenched in a water bath and dried off using a blower.

ADVANTAGES AND DISADVANTAGES

Epoxy resins are selected for their non-polluting properties and their excellent adhesion properties on ferrous substrates. Epoxy resins are semi-flexible, possessing excellent corrosion resistance. These materials, however, are softer than the galvanizing or zinc coating.

The speed, at which the wire is fed through the machine, is high. It is not known what effect the speed will have on the epoxy coated wire during the baling operation.

FLOW CHART

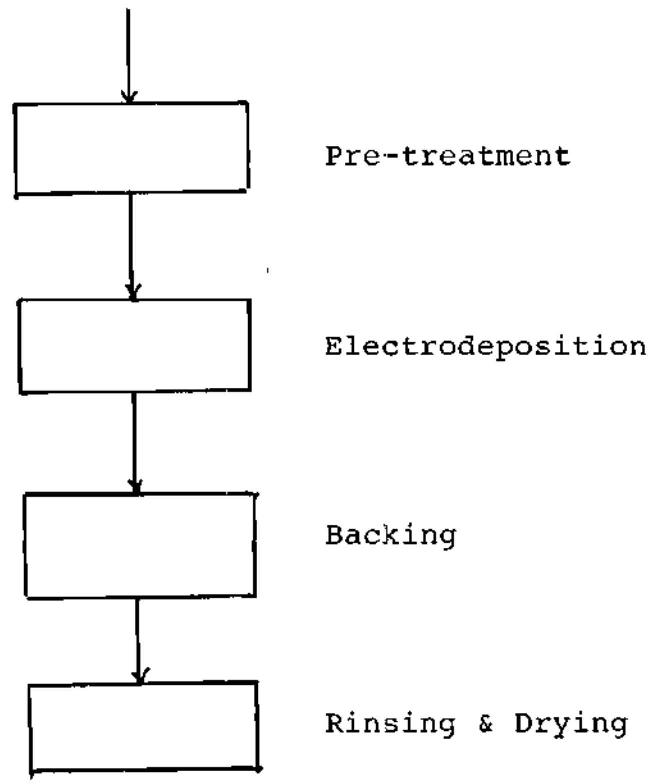

Figure 2: Schematic showing electrodeposition process

CAPITAL INVESTMENT

Dipping Process:

The start-up equipment cost will be dependent on the size of the operation but is considered to be a moderate investment. All the necessary parts can be designed, manufactured and installed in-house. The curing furnace can be purchased from suppliers. Epoxy resins and curing agents are moderately priced.

1) Resin/hardner (Shell Chemical Co.)

   Epon 828/Hardner

   $4 to $6 per pound

2) Toluene solvent

   $3 per pound

Electrodeposition Process:

The start-up equipment cost will again depend upon the production output. The electrodeposition tanks are readily available in the market. Other parts can be designed, manufactured and installed in-house. Epoxy resins and curing agents are moderately priced.

The total capital investment probably will be higher than the dipping process. This process, however, has advantages over the dipping process. The process is fast and the coating thickness can be controlled more precisely than the dipping process.

LABORATORY TESTS

Samples of steel wire (1050-1060 AISE, 0.104" diameter) were submitted by Cavert Wire Company for coating tests. Samples were identified as "black" wire and "blue" coated wire. Also submitted was a coil of galvanized wire.

Two techniques 1) dipping and 2) electrodeposition were utilized to coat the surface of the steel wire.

DIPPING PROCESS

The purpose of this test was to determine whether a thin film of coating would be obtained on the wire surface by simply dipping it into the coating solution. Prior to coating the wire, the "black" wire was cleaned using a suitable solvent to remove the oxide scale and the oil particulates. An epoxy resin EPN 828 (Shell Company) was mixed with a curing agent according to manufacturer's specifications. The solutions was then diluted with toluene as solvent in different proportions. The cleaned samples were dipped into the coating solution at room temperature for approximately five seconds and dried in an oven at 50°C for approximately two hours to accelerate the curing process.

Figure 3 shows the coated wires with 100% coating solution (no solvent), 10% diluted coating solution and 20% diluted coating solution. A thick film was obtained using 10% and 20% diluted coating solutions. In the photomacrograph the coating could not be visible since the applied film was colorless.

It should be noted that the coating thickness was not controlled during the test. The coating thickness, however, can be controlled as proposed in the outlined procedure.

ELECTRODEPOSITION PROCESS

Approximately 50 feet of wire was utilized for this test. Prior to coating process, the wire surface was cleaned using a suitable solvent. A solution consisted of premixed epoxy, solvent and water was prepared according to the specifications.

Bath Concentration

Water 80%

Epoxy 19%

Solvent 1%

The cleaned wire was submerged into the tank containing the coating solution. A negative voltage was applied to the wire. The bath temperature was kept between 75°F to 90°F. The coated wire was then placed in the curing oven at 400-450°F for approximately two minutes, quenched and dried.

Examination of the sample indicated that the coating was nicely deposited onto the surface as shown in Figure 4. Transverse cross-sections were mounted and polished for optical microscopic examination. Figures 5 and 6 show the transverse cross-sections of the coated wire. The coating was well adhered to the wire surface as shown in Figures 5 and 6. The average coating thickness was found to be 0.0225 mm (0.0089").

The submitted galvanized wire was examined for coating. Figures 7 and 8 show the transverse cross-sections of the galvanized wire. Examination of the cross-sections indicated that the coating was not uniform and was found to be extremely thin as compared to the electrodeposited coating.

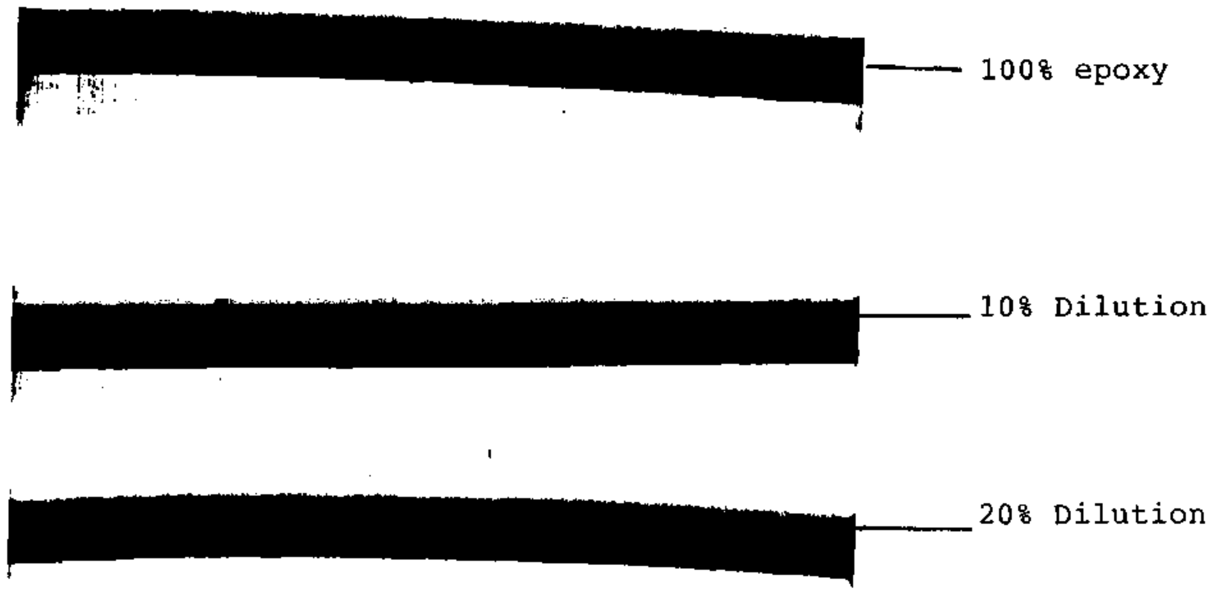

Figure 3. Photomacrograph showing coated wires with epoxy Dipping Process.

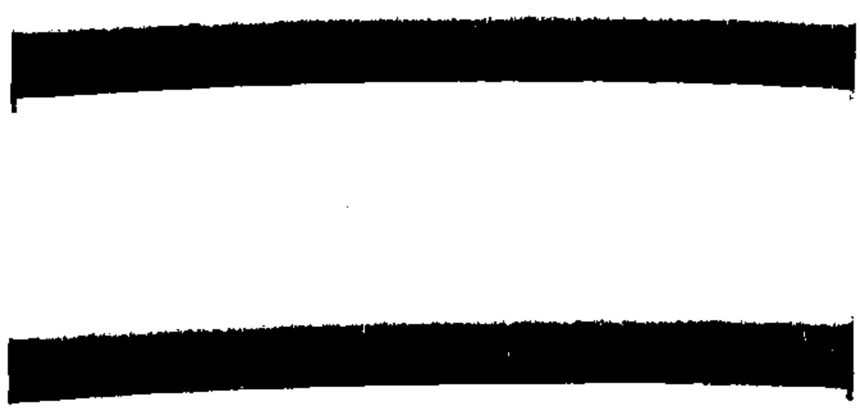

Figure 4. Photomacrograph showing coated wires with Electro-deposition Process.

Figure 5 330X

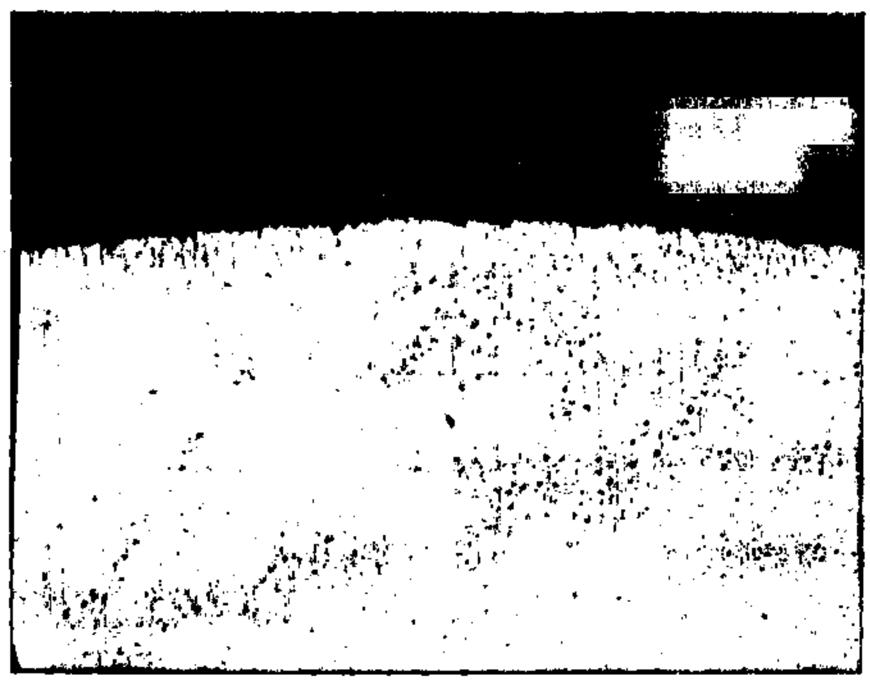

Figure 6 330X

Figures 5 & 6: Transverse cross-sections showing electro-deposited epoxy coating thickness on steel wire.

Figure 7 330X

Figure 8 330X

Figures 7 & 8: Transverse cross-sections showing galvanized or Zn coating thickness on steel wire.