WORLD ENVIRONMENT CENTER

UKRAINE

WASTE MINIMIZATION DEMONSTRATION PROJECT

AT

STEEL WIRE PLANT "SILUR"

IN KHARTSYZSK

Final Report

USAID/WEC COOPERATIVE AGREEMENT
NO. ANE-0004-A-00-0048-00

World Environment Center
419 Park Avenue South, Suite 1800
New York, New York 10016

APRIL 1997

Project Description:

Reduction of copper losses at welding wire production facilities at Steel Wire Plant "Silur" in Khartsyzsk.

Project Type: Waste Minimization Demonstration Project

Country: Ukraine

Industrial Sector: Metallurgical

Funding Source: United States Agency for International Development

Participants: Steel Wire Plant "Silur" and WEC

Project: Improvement to process control of welding wire copper plating

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I. INTRODUCTION

In September 1995, an amendment was added to the United States Agency for International Development's (USAID's) and World Environment Center's (WEC's) Cooperative Agreement No. ANE-0004-A-00-0048-00 to include Ukraine as one of the additional countries to receive WEC's technical assistance, training and information dissemination services related to urban and industrial pollution control.

WEC's activities in Ukraine are implemented in two phases as follows:

Phase I - Initiated in October 1995. Under this phase, the program focuses on reduction of environmental pollution caused by industrial activities through waste minimization. This includes better utilization of natural resources and conservation of energy, with emphasis on financial benefits. Waste Minimization Demonstration Projects (WMDP) were established at four industrial enterprises in the Donetsk region. The goal is to demonstrate to these enterprises the cost savings and reduction of environmental pollution from waste minimization and to encourage the incorporation of this program into the permanent policy of plant management.

Phase II - Initiated in September 1996. This program is similar to Phase I, with additional emphasis on energy conservation, specifically on reduction of natural gas consumption. Six Waste Minimization/Energy Conservation Demonstration Projects (WM/ECDP) are being implemented at various plants in Donetsk and Dnipropetrovsk regions.

The report submitted herewith pertains to a demonstration project at the Steel Wire Plant "Silur", which was one of the four enterprises selected for a WMDP under Phase I in the Donetsk region. The subject of the project was "Improvement to Process Control of Welding Wire Copper Plating", with the goal of reducing quantities of copper discharged into the environment. The project was initiated in October 1995 and concluded, with some interruptions, in February 1997. Those interruptions which delayed completion of the project, were caused by the lack of orders for copper plated wire, as well as a shortage of raw material.

Final findings and conclusions resulting from this Waste Minimization Demonstration Project are presented in this report.

II. EXECUTIVE SUMMARY

Pursuant to the technical assistance program for Central and Eastern European countries funded by the United States Agency for International Development, the World Environment Center conducted a Waste Minimization Demonstration Project at the Steel Wire Plant "Silur" in the town of Khartsyzk, Donetsk region in Ukraine. The project involved *improvements to process control of welding wire copper plating.* It was anticipated that by implementing this project, about 3 tons/year of copper would be prevented from discharge into the environment, and financial savings in the range of $26,000/year would be accomplished. In addition to technical expertise, WEC provided the following equipment for this project:

1. A coulometric tester for measuring the copper plating thickness;

2. On line monitor for instantaneous indication of the copper desposition rate (for prompt adjustment of the copper plating solution chemicals); and

3. Electronic micrometers to improve wire measuring accuracy.

In addition, WEC provided "Silur" with a proprietary analytical procedure from a U.S. manufacturer of plating equipment (simplified plating solution test methods). Also, WEC recommended a trial of proprietary copper sulfate mixture to stabilize the dissolved iron, minimizing the frequency of dumping copper solution. All equipment including the analytical procedure cost $9,527 and arrived at the plant in August 1996.

It should be noted that in order to locate proper equipment, a quite extensive search of US markets was necessary.

Following the arrival of equipment at the plant, WEC's specialist provided assistance in the calibration, installation and start-up, and established a procedure for recording project data.

In January 1997, the plant resumed operation of the welding wire copper plating facility with the use of new monitoring equipment. At the same time, they initiated recording and compiling operational data. As established previously with WEC's specialist, recording was continued for about 2 months. Subsequently, "Silur" developed and issued a report summarizing recorded data and results of the demonstration project (see Chapter V). The report confirms that, as anticipated, the demonstration project undertaken will yield about $26,000/year in financial benefits and prevent about 3 tons/year of copper sulfate from being discharged into surface waters. The financial benefits were obtained due to improved efficiency of utilization of copper sulfate and reduced labor and energy costs. In addition, new equipment providing instantaneous and continuous information on plating performance allowed more effective process control, reducing the quantity of off-specification product.

In conclusion, it can be stated that the active cooperation on the part of "Silur" in the implementation of this successfully completed project has clearly demonstrated the plant management's interest in the waste minimization concept. It seems that the "Silur" management is fully convinced now of the potential benefits from such pollution prevention strategy, and thus, the WEC's goal for demonstration projects was achieved.

III. GENERAL BACKGROUND AND ACTIVITIES

1. Purpose of Project

The purpose of this demonstration project was to promote the waste minimization concept among industrial enterprises. The Waste Minimization Demonstration Project established at "Silur" was intended to meet the World Environment Center's criteria as follows:

- Reduction of waste at the process source;
- Improvement in environment;
- Modest capital investment;
- Significant cost savings relative to investment; and
- Accomplishment of the above within a short time frame.

2. Plant Overview

The Silur plant was established in 1949 as a steel wire and rope factory and is located about 40 km northeast of the city of Donetsk in the town of Khartsyzsk. It produces steel wire, wire rope and a large variety of industrial wires such as upholstery, wire fences, tire cords (the only plant in Ukraine to supply wire for reinforcement of automobile tires), various types of mesh specialty products for the building and construction industry, construction nails, small-diameter pipes, weld wire for the automobile industry, heat-treated wire for the fasteners and a number of other metal products. There are 12 main and 8 auxiliary shops where about 6,000 people are employed.

A substantial portion of the equipment and technology was purchased from Germany, Italy, Sweden, United States and Canada.

Silur is participating in at least three joint ventures--one with a Canadian company to produce metal furniture and conduits; another with a Cyprus company to produce fasteners; and with and American company to produce steel wool for automotive brakes--

replacing asbestos containing material. A large portion of the production is exported to 26 countries including the U.S.

3. Selected Demonstration Project

Following a number of meetings and mutual consultations between WEC's specialists and the plant management, "Improvement to process control of welding wire copper plating" was selected as the Waste Minimization Demonstration Project. In connection with this project, the following problem areas were identified at the wire copper plating facility:

a. Plating solution analysis was done only once each shift and was performed in the analytical laboratory about four blocks away. The analysis method was a series of titrations (wet chemistry) that takes an hour. Consequently, additions of sulfuric acid and copper sulfate was made only once a shift and control of the copper plating thickness seemed to be inadequate. Silur's specifications require a minimum of 0.15 microns of copper thickness but the plant often plated 0.7 to 0.8 microns.

b. The copper plating thickness on the wire was at that time determined by a gravimetric method (where a cut wire sample was measured, weighed, the copper dissolved and the thickness calculated from the weight loss). This procedure required about an hour. Samples were taken only when the plated welding wire re-wound onto smaller spools so results were not immediately available. This is a second reason why existing controls did not adequately regulate the plating.

c. As the steel wire enters the copper plating solution, some of the wire surface dissolves in the highly acidic solution before it is coated with copper. This iron (Fe) from the steel gradually increases in concentration. After about a week, this build-up results in poor copper plating. Current practice is to dump the used solution into the sewer system and make up a new mixture. This adds to cost and also causes environmental pollution since dumps go untreated to a small lake.

d. The above weekly solution dumps resulted in 3600 liters per month of copper sulfate solution released into the surface waters. No attempt was made to recover the dissolved copper, a considerable loss. Note: This does not include the copper loss due to overplating the welding wire.

e. The manual micrometers used at Silur could give inaccurate readings when discerning the small markings. This could occur when checking the bare drawn steel wire diameter.

Key to reducing the over-plating of copper (loss of valuable metal), losses from dumped solutions and resultant pollution, is the adequate testing of the controlling chemical

concentrations. The existing analysis methods were too slow and costly to provide the necessary data promptly enough to adjust the process operation.

4. Monitoring Equipment

To improve the welding wire copper plating process, WEC provided the following:

a. For plating solution analysis - proprietary test procedures to measure concentrations of sulfuric acid, metallic copper and ferrous sulfate. Each of these tests can be done in about **10 minutes - versus 1 hour** previously required.

b. Plating Thickness Tester - a coulometric type tester which anodically deplates a test area and the thickness is determined by the current and time required to remove the plating. The instrument allows testing a sample in about **60 seconds - versus 1 hour** previously required.

c. Plating Rate Monitor - this instrument provides instantaneous indication of the copper deposition rate (for prompt adjustment of the copper plating solution chemicals).

d. Electronic Digital Micrometers - to improve accuracy of bare wire diameter readings.

Total cost of the equipment was about $9,500.

IV. FINAL CONCLUSIONS

After installation of monitoring equipment and recording project data for several weeks, "Silur" reported that copper sulfate consumption decreased, along with energy and labor costs. Also, the quantities of waste from the spent copper sulfate solution discharged into surface waters were reduced.

The resulting payback period for the project is about 4 months.

In conclusion, it should be noted that the main goal of the Waste Minimization Demonstration Projects was to influence and encourage enterprises to permanently adopt a waste minimization program into their plant policy. It seems that this demonstration has successfully implanted such an idea at "Silur", proving that protecting the environment can also be a source of financial benefit.

For more details on this project, refer to Progress Reports No. 1, No. 2 and No. 3.

As a final note, WEC would like to acknowledge "Silur's" management for their excellent cooperation during implemention on this project. Mrs. Ljubov Masich, Ecology Technical Director, and Mr. Vladimir Artjomov, Deputy Technical Director, deserve special recognition for their contribution, patience and courtesy.

V. "SILUR REPORT ON PROJECT RESULTS"

Р А С Ч Е Т

ожидаемого экономического эффекта от внедрения установок (приборов) замера толщины медного покрытия на сварочной проволоке и концентрации раствора.

Внедрение приборов контроля толщины медного покрытия на сварочной проволоке и концентрации раствора позволит снизить расход медного купороса, вспомогательных материалов, снизить общезаводские затраты и улучшить экологическую обстановку в регионе.

Экономический эффект определяется по формуле:

$$Э = [\Delta C_i - Eн (K_2 - K_1)] \times A_2 ,$$

где ΔC_i - изменение затрат по i-ой статье, карб.

K_2, K_1 - капитальные затраты на внедрение, карб.

A_2 - годовой обьем производства продукции, тн

Исходные данные для расчета:

№№ пп	Статья расхода	Ед. изм.	Показатели до внедр.	Показатели после внедр.	Примечани
I	2	3	4	5	6
I.	Расход медного купороса	кг/т	5	3	
2.	Оптовая цена медного купороса	млн крб/т		I80	
3.	Годовой обьем производства омедненной сварочной проволоки.	тн		I500	
4.	Общезаводские затраты	тыс. крб/т	I3303	I2239	
5.	Энергетические затраты	"	7046	6482	
6.	Затраты по топливу	"	245I	2255	

I	2	3	4	5	6
7.	Затраты на вспомогательные материалы	тыс.крб/т	2500	2312	
8.	Экономия по зарплате: сокращение 4-х лаборантов, производящих анализы.	млн.крб.	576	-	
9.	Улучшение экологической обстановки (уменьшение сбросов меди в канализацию).	"	600	-	
10.	Дополнительные капитальные затраты.	"	-	-	

Ожидаемый экономический эффект от внедрения установок для контроля медного покрытия на сварочной проволоке и концентрации раствора составит:

$$Э = \left[(0,005-0,003)\times 1500\times 180\right] + \left[(13303-12239)+(7046-6482)+(2451-2255)+(\right.$$
$$\left.+(2500-2312) + 576 + 600\right] \times 1500 = 4734,1 \text{ млн крб, или } 25940\$ \text{ СШ}$$

Руководитель экономической службы

Руководитель технической службы

ESTIMATE (Translation)

of

environmental benefit and cost saving to be reached after equipment is installed to measure welding wire copper plating thickness and plating solution composition

Application of proper instruments to measure copper plating thickness on welding wire and plating solution concentration will allow to lessen consumption of copper sulphate, auxiliary materials, reduce factory overheads and improve the environment in the area.

Financial savings are to be calculated as follows:

$$Э = [\ \Delta Ci - E_н(K2 - K1)] \times A2\ ,$$

where

ΔCi - costs difference for "I" item (from the table below), karbovanets;

K2,K1 -the project accomplishment costs, karbovanets;

A2 - total annual ouput, MT.

Basic figures for the estimate:

Item No	Description	Unit of Measurement	Amounts		Remarks
			before the event	after the event	
1	2	3	4	5	6
1	Copper sulphate consumption	kg/MT	5	3	
2	Wholesale price of copper sulphate	million karb./MT	180	180	
3	Total annual ouput of welding wire	MT	1500	1500	
4	Factory overheads	thousand of karb.	13,303	12,239	
5	Heat and power costs	as above	7,046	6,482	
6	Fuel costs	as in item4	2,451	2,255	
7	Auxiliary materials costs	as in item 4	2,500	2,312	
8	Labor costs savings(the analytical lab staff to be reduced by 4 employees)	million of karb.	576	-	

9	Emprovement of the environment (through lessening of copper discharges and avoiding paying fines to the authorities)	as above	600	-	

The anticipated financial savings following the application of a copper plating thickness controlling instrument and a plating solution concentration meter will be calculated as follows:

Э = [(0.005 - 0.003) × 1500 ×180] + [(13,303 - 12,239) + (7,046 - 6,482) + (2,451 - 2,255) + (2,500 2,312) + 576 +600] × 1,500 = 4,734.1 mln. karb. = $25,940.

Signed by:

Head of Economical Dept,

Head of Technical Dept.

P.S. Environmental benefit is reduction of copper sulphate discharges to the surface water. It could be calculated for a year period as follows:

(5 - 3)kg/MT × 1500MT =3,000 T.