WORLD ENVIRONMENT CENTER

UKRAINE

ENERGY CONSERVATION/WASTE MINIMIZATION DEMONSTRATION PROJECT

AT

CHEMICAL PLANT

IN PAVOLOGRAD

Final Report

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

World Environment Center
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Project Description	Reduction of natural gas consumption
Project Type	Energy Conservation/Waste Minimization Demonstration Project
Country	Ukraine
Industrial Sector	Chemical
Dates	November 1996
Funding Source	United States Agency for International Development
Participants	Pavlograd Chemical Plant and World Environment Center
Project	Project #1 – Improvement in efficiency of Boiler No 1
	Project #2 – Improvement in automatic control of Boiler No 1 (Not implemented)
	Project #3 – Improvement in efficiency of Boiler House No 3

REPORT DISTRIBUTION

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I INTRODUCTION

In September 1995, the World Environment Center (WEC) initiated the program providing technical assistance, training and information dissemination services related to industrial pollution control in Ukraine This activity is performed within the framework of a much broader assistance program to Ukraine funded by the United States Agency for International Development (USAID) and involves a whole spectrum of large-scale issues

WEC's program in Ukraine is implemented in two stages as follows

Stage I – called **Demonstration Project** includes a number of Energy Conservation/Waste Minimization Demonstration Projects (EC/WMDP) implemented at various large industrial plants The main goal of this stage is to *demonstrate* to these enterprises the beneficial aspects of a Waste Minimization/Energy Conservation Program Through the *demonstration projects*, an effort is made to encourage enterprises to incorporate such programs into the permanent policy of plant management The intent is, among other things, to demonstrate that pollution prevention and energy conservation programs are not just additional expenses, but help to improve *production efficiency* and subsequently increase *profitability* of the enterprises A number of demonstration projects were established at selected plants in the Dnipropetrovsk, Donetsk and Lviv regions Some of them are already completed, others are underway

Stage II – of WEC programs in Ukraine is called the **Impact Program** The intent of this stage is to *disseminate to a much wider audience* energy conservation and waste minimization concepts and the benefits resulting therefrom To further the impact of the demonstration phase, seminars and workshops were held for plant managers from major industrial enterprises In addition, study tours were organized in the U S

Under Stage I, one of the plants selected is the Pavlograd Chemical Plant located in the town of Pavolograd, Dnipropetrovsk region Three demonstration projects were selected, but one project (Project #2) was abandoned due to inability to obtain replacement parts Instrumentation was purchased by WEC for Projects #1 and #3 and shipped to the plant The equipment was installed and operated satisfactorily

Based on the successful operation of these projects, Pavlograd Chemical prepared a report (Appendix A) describing the resulting reduction in natural gas consumption and presenting the accompanying benefits, which is included herein

II EXECUTIVE SUMMARY

Visits by WEC teams to Pavlograd Chemical Plant (PCP) were conducted in October 1996, October 1997 and April 1998 Identification of three Energy Conservation/Waste Minimization Demonstration Projects was made in October 1996 However, one of the projects, Project #2, was later abandoned due to inability to obtain replacement parts to improve automatic control of Boiler #1 Succeeding visits to the plant were made to follow-up on implementation of Projects #1 and #3 and to provide guidance on the data collection needed to estimate annual benefits

The plant began operations in 1929 as a munitions factory making black powder and projectiles It is located in the town of Pavlograd in Dnipropetrovsk region Currently, the plant employs about 4,000 workers and occupies an area of about 1,000 hectares which includes about 900 buildings, 100 km of rail tracks, 170 km of pipelines, housing for 15,000 people and a powerhouse supplying hot water for domestic use and heating

Presently it manufactures explosives for industrial uses, polyvinylacetate dispersion, polyethylene injection moldings, paints and varnishes, toothpaste and other products Black powder and solid fuel for rocket motors is no longer produced at the plant PCP is being considered as the contractor for the removal of solid fuel from Soviet ICBM rocket motors, using technology being developed by the U S A The plant is under the jurisdiction of the Ministry of Machinery, Buildings and Conversion, in the Division of Military Complex and Conversion

Detailed descriptions of plant operations and the selected demonstration projects are described in Progress Report No 1, issued February 1997

The plant has prepared a report (see Appendix A) summarizing the performance of these demonstration projects as follows

Project Description	**Equipment Provided**	**Calculated Energy/Material Savings ($US/year)**	**Projected Annual Gas Conserved (m^3/year)**	**Payback Period (month)**
Project 1 Improvement in Efficiency of Boiler #1	In-Situ Oxygen Analyzer @ cost of $11,600	$21,400	195,500	6 5
Project 3 Improvement in Operating Efficiency of Boiler House No 3	Portable Gas Analyzer @ cost of $ 4,800	$42,900 (in 2 boilers)	391 000 (in 2 boilers)	1 5
Total	$16,400	$64,300	586,500	3 0 (av value)

II- FINDINGS AND CONCLUSIONS

Findings and conclusions for the two completed EC/WMDP projects are given below

Project No 1 – Improvement in Efficiency of Boiler No 1

This boiler is one of three existing units installed in Boiler House No 3 The lack of a functioning oxygen analyzer did not allow operation of this boiler at optimum efficiency since no measurements were available indicating the concentration of excess oxygen in the stack gases The demonstration project selected for implementation projected the installation of a new in-situ gas analyzer and visualized resulting efficiency improvement of about 1 5% which would result in annual benefits of about $36,000 year

WEC provided an in-situ gas analyzer which was installed in boiler N3 GM50 and placed in operation by July 1998 Pavlograd Chemical Plant (PCP) reported (see Appendix) that the oxygen content in the exhaust gases decreased from 6% to 2% following the installation of the gas analyzer This resulted in an increase in thermal efficiency of the boiler of 1 16%, saving 25 52 m^3/hr of natural gas

PCP estimates that the annual reduction in consumption of natural gas is 195,483 m^3 with an economic benefit of $21,400/year

Project No 2 – Improvement in Automatic Control of Boiler No 1

This project was abandoned since the replacement parts for the non-operating components of the existing automatic boiler control system were not available

Project No 3 – Improvement in Operating Efficiency of the Entire Boiler House No 3

This project visualized a potential increase in thermal efficiency of the Boiler House of about 1 5% by adjusting the burners on all the boilers to minimize excess air levels and still assure that excessive CO is not present in the exhaust gases, thereby reducing the quantity of flue gases emitted and the emissions of combustibles

WEC provided a portable gas analyzer for analysis of O_2 and CO and combustibles in exhaust gases, thus allowing for adjustment of the burners in the boilers to provide improved thermal efficiency

As stated in attached PCP Report (see Appendix), the portable gas analyzer (MAX 5) was installed and placed in operation in boilers N1, N2 of the GM 50-14 type Oxygen concentration in the exhaust gases was measured and adjusted to improve thermal efficiency The oxygen concentration was lowered to 2% from 6% before adjustments were made as a result of use of the portable gas analyzer The accompanying reduction in heat loss in the exhaust gases is 1 16% with hourly savings of 25 52 m^3 of natural gas in one boiler For one year, in one boiler, the annual savings in natural gas are estimated at 195,483 m^3 The annual natural gas savings resulting from the use of the portable gas analyzer in 2 boilers is estimated at 390,966 m^3 valued at $42,900

III CHRONOLOGY OF PROJECT

November 1996	-	WEC Team visited plant and identified 3 projects,
April – July 1997	-	WEC issued purchase orders for instrumentation for Projects #1 and #3,
April – July 1998	-	Arrival of instrumentation at Pavlograd Chemical Plant,
July – August 1998	-	Instrumentation installed and collection of operating data initiated, and
September 1998	-	Final Report issued

IV APPENDIX A

(Report developed by the Plant)

Pages: 6
(including cover)

REPORT

on the energy saving arrangements

execution at Pavlograd Chemical Plant

PAVLOGRAD
1998

REPORT

on the energy saving arrangements execution

at Pavlograd Chemical Plant (PCP) boiler-house.

In compliance with the project oxygen analyzer WORLD CLASS 3000(probe) with the intelligent field transmitter (IFT) 3000 measuring oxygen content in extracting gases has been installed and put into operation at PCP boiler-house in boiler N3 GM 50

The primary ananyzer transformer is positioned in the smoke gases outlet from the boiler

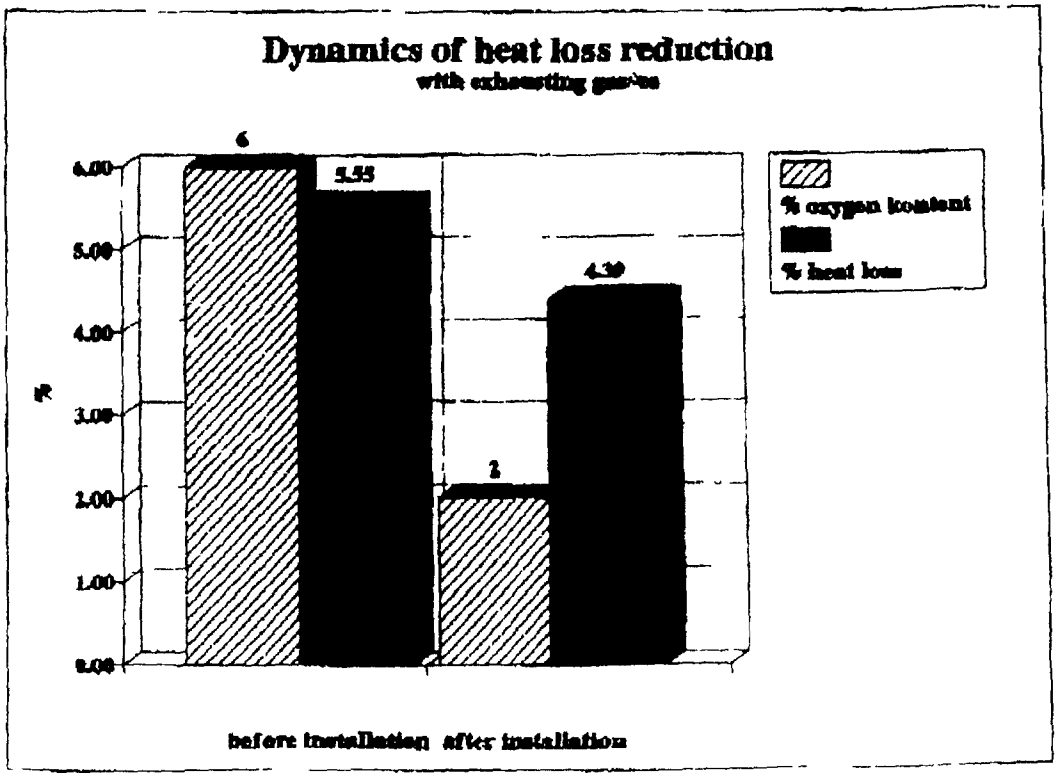
Display is installed in the technical service site

Exhausting gases temperature in the transformer areas does not exceed 400°C.

Regulation of oxyden content in exhausting gases is provided by analyzer readings in hand-operated mode

Gas consumption measurement is made in the gas pipe at the boiler inlet

Acceptable calculations using all the series of values defined saving gas consumption on the oxygen content reduction



Oxygen analyzer efficiency

Oxygen content in exhausting gases before analyser installation	- 6%
Oxygen content in exhausting gases after analyser installation	- 2%
Heat loss reduction in exhausting gases	- 1 16%
Hour saving consumption of natural gas	-25 52 m³
Natural gas saving (per year) (in one boiler)	- 195483 m³
Estimated annual saving gas (in one boiler)	-32587 grivn
Estimated annual NO exhaust reduction (by one boiler)	- 0 12 t
Oxygen analizer purchase	- 12000 grivn.
Oxygen analizer installation	- 700 grivn
Other expenses	- 1110 grivn.
Total amount:	- 13800 grivn

Estimated efficiency of oxygen analizer installation in 3 boilers	
Natural gas saving	- 586449 m³
Saving gain	-115781 grivn
NO exhaust reduction	- 0 36 t.
Oxygen analizers in 3 boilers	- 41400 grivn

Chief power engineer A Kudrsavtsev

CALCULATION

OF GAS FLOW REDUCTION

in boiler [illegible] reducing oxygen content
in exhausting gases from [illegible] to 2

heat loss with exhausting gases

$$q_2 = \frac{t_{ex} - t_a}{t_{max}} [illegible] (B \cdot K) \times 100\%$$ where

t_{ex}, t_a, t_{max} – exhausting gases temperature, air temperature, natural gas heat production [illegible]

– correction factor [illegible] the ratio of [illegible] capacity of [illegible] during [illegible] product [illegible] t_{ex} to [illegible] t_{max} capacity from 0 to [illegible]

K – coefficient showing the ratio of [illegible] to the [illegible] volume increasing excess air content [illegible] RO_2 [illegible] RO_2 [illegible] in theoretical [illegible]

B – coefficient showing the ratio of [illegible] [illegible] volume air products [illegible] to the [illegible] in theoretical conditions [illegible]

[illegible]

$t_{ex} = 1[illegible]°C$ – measurement

$t_a = 20°C$ – measurement

$t_{max} = 2[illegible]10°C$ – reference value

$C = 0.[illegible]$ – reference value

$K = 0.[illegible]$ – reference value

[illegible] – reference value

$B = 0.[illegible]1$

$$q_2 = \frac{1[illegible]4 - 20}{20[illegible]} = [illegible]$$ [illegible]

REPORT

on the energy saving arrangements execution

at Pavlograd Chemical Plant (PCP) boiler-house.

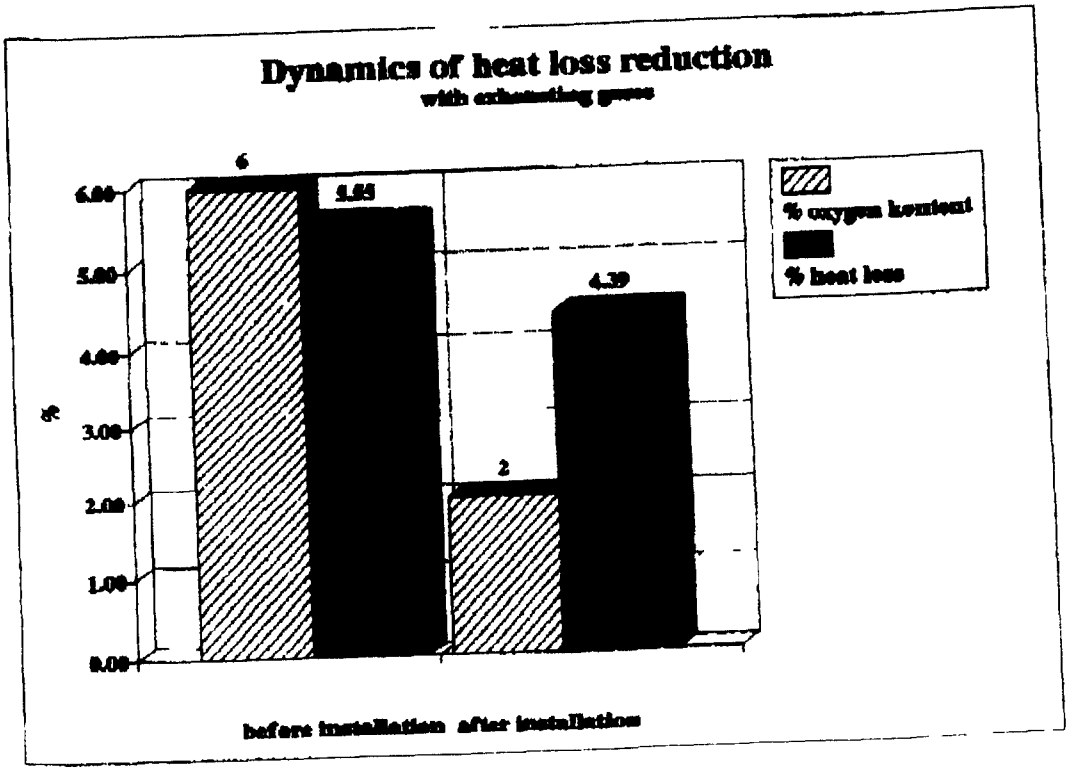
In complience with demonsrational project N2 gas analyzer MAX 5 measuring oxygen content, carbon mono-ide, carbon dioxide, total combustion, combustion temperature and officiency has been installed and put into operatio at PCP boiler-house in boilers N1 N2 GM 50-14

Analyzer transducer is installed in chimneys between boilers N1 and N2 air-heater and ekonomyzer and in other required and suitable for analysis plazes.

Regulation of oxygen content in exhausting gases is provided by analyzer readings in hand-operated mode

Gas consumption measurement is made in the gas pipe at the boiler inlet.

Flow gas reduction due to the oxygen content is lowered in exhausting gases has been defined(designed) by estemated method and using meaasurement readings required for parameters and adjusting boiler units GM 50-14 results evaluation



Gas analyzer efficiency

Oxygen content in exhausting gases before analyser installation	- 6%
Oxygen content in exhausting gases after analyser installation	-2%
Heat loss reduction in exhausting gases	- 1 16%
Hour saving consumption of natural gas	-25 57 m³
Natural gas saving(per year) in one boiler GM 50-14	- 195483 m³
Estimated annual saving gas in one boiler GM 50-14	- 38587 grivn
Estimated annual NO exhaust reduction (by one boiler GM 50-14)	- 0 12 t
Gas analyzer purchase	- 10800 grivn
Other expenses	- 900 grivn
Total amount*	- 11700 grivn

Estimated efficiency of gas analyzer installation in two boilers GM 50-14 *	
Natural gas saving (per year)	- 390966 m³
Saving gain	- 77174 grivn
NO exhaust reduction	- 0 24 t
Gas analyzer in two boilers	- 11700 grivn

Chief power engineer A Kudr avtsev