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WORLD ENVIRONMENT CENTER

UKRAINE

ENERGY CONSERVATION/WASTE MINIMIZATION DEMONSTRATION PROJECT

AT

DNIPROAZOT CHEMICAL PLANT

IN DNIPRODZIERZYNSK

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

AUGUST 1998

Project Description	Reduction of natural gas consumption
Project Type	Energy Conservation/Waste Minimization Demonstration Project
Country	Ukraine
Industrial Sector	Chemical
Funding Source	United States Agency for International Development
Participants	Dniproazot Chemical Plant and World Environment Center
Project	#1 - Improvement in combustion efficiency of reformer in Ammonia Plant #2 - Improvement in Power House condensate conservation #3 - Improvement in steam condensate collection/reuse

B

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I INTRODUCTION

In September 1995, the World Environment Center (WEC) initiated 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 Program** 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 Dniproazot Chemical Plant located in the city of Dniprodzierzynsk At this enterprise, three demonstration projects were selected, equipment purchased by WEC and shipped to the plant and installed Based on the successful performance of these projects, Dniproazot prepared a report (Appendix A) describing the resulting reduction in natural gas consumption and presenting the accompanying benefits, which are described herein

Acknowledgement

At this time with the three energy conservation projects successfully completed by Dniproazot Plant WEC wishes to express its sincere appreciation for the excellent cooperation of Dr Vladimir Fedorov Technical Director and Deputy Chairman of the Board in implementing these projects In addition the excellent support of Dr Fedorov for the WEC overall program of Energy Conservation and Waste Minimization is hereby recognized

II EXECUTIVE SUMMARY

Visits by WEC teams to Dniproazot Plant were conducted in November 1996, October 1997, April 1998 and June 1998 Identification of three Energy Conservation/Waste Minimization Demonstration Projects was made in November 1996 Succeeding visits were made to follow up on implementation of the projects and to review the benefits obtained

The Dniproazot Chemical Plant became a joint-stock company in 1996 The main production units are two ammonia plants and two urea plants The ammonia plants are each rated at 350,000 tons per year Other production units at the plant manufacture chlorine, PVC resin and various specialty organic chemicals Natural gas is burned in each of 5 boilers to produce a total of about 800 tons of steam per hour and the Plant currently employs about 8,000 people

Detailed descriptions of the plant operations and the three selected demonstration projects are provided in Progress Report #1 issued November 1997

A summary of the benefits obtained following the implementation of the demonstration projects as estimated by Dniproazot Plant is given below

Dniproazot Facility

Summary of Estimated Benefits

Project Description	Cost of Equipment ($US)	Calculated Energy/Material Savings ($US/year)	Projected Annual Gas Conserved (M^3/year)	Payback Period
Project 1 Improvement of Reformer Combustion Efficiency	$15,400 (In-situ Combustion Gas Analyzer)	$62,000	690,000	3 months
Project 2 Improvement in Power House Condensate Conservation	$ 3,352 Conductivity Meters (2)	$ 70,000	770,000	< 1 month
Project 3 Improvement in Steam Condensate Collection/Reuse	$ 7,220 (Steam Traps)	$104,000	1,150,000	< 1 month
Total	$25,972	$236,000	2,610,000	

The final close out meeting was held on July 31, 1998, at which time, a Certificate of Recognition was awarded to Dniproazot Plant for participation in WEC's program

III FINDINGS AND CONCLUSIONS

Findings and conclusions for the three individual EC/WMDP projects is given below

Project #1 - Improvement in Combustion Efficiency of Reformer in Ammonia Plant Through installation of Combustion Gas Analyzer

The reformers in each of the ammonia plants are the second largest energy consumer at the Dniproazot Plant The existing control procedure for combustion of natural gas is to manually collect daily flue gas samples and analyze for oxygen and combustibles in an on-site laboratory Fuel to combustion air ratios are subsequently adjusted based on the results of the sample analysis The results of the flue gas analyses and resulting combustion feed adjustments are logged in the respective ammonia plant or power house log books Typically, several hours may elapse between the time a sample is collected and the adjustment in the combustion system is made

This project required the installation of a combustion gas analyzer, control unit and recorder for monitoring of oxygen and combustibles in the flue gas "split" of the Ammonia Plant reformer The proposed instrumentation allows for continuous measurement and adjustment (with a 4-20mA signal from the controller) of combustion efficiency at the reformer gas burners

This gas analyzer, which measures oxygen content in the flue gas, allows the rapid and efficient control of the oxygen content so as to reduce the quantity of excess air to the boiler, thus improving the combustion efficiency with resulting decrease in consumption of natural gas

Dniproazot Plant reports (see Appendix A) that as a result of the installation of this on-line analyzer, the efficiency of the boiler increased from 92 4% to 92 91% Based on this improvement, Dniproazot Plant estimates an annual reduction in consumption of natural gas of **690,000 m^3/year** with a monetary benefit of **$62,000** using a price of $90 for 1000 m^3 natural gas

Project #2 - Improvement in Power House Condensate Conservation Through Installation of Conductivity Meters

Return of steam condensate for reuse as boiler feedwater requires close monitoring to ensure suitable quality prior to acceptance by the boiler house Usual practice was to manually remove condensate samples for quality analysis When off specification condensate is detected, the condensate is diverted to industrial sewer system

Following the installation in February 1998 of 2 conductivity meters supplied by WEC, the detection of quality violations in the steam condensate was much more rapid than with the previous procedure of manual removal of samples and subsequent laboratory analysis, thus resulting in a reduction in the amount of steam condensate diverted to industrial sewer system

Based on the attached report from Dniproazot Plant (Appendix A), it is estimated that 1998 loss of steam condensate following installation of the conductivity analyzers amounts to 915 m^3 compared to a loss in all of 1997, prior to installation of the conductivity meters of 25,484 m^3 The resulting reduction in annual loss of steam condensate is estimated at 24,569 m^3 with related benefits as follows

Reduced energy losses	= $49,500
Reduced desalting costs	= 20,437
Total Annual Benefit	**$69,937**

The total annual accompanying reduction in usage of natural gas is estimated at **770,000 m^3**

Project #3 - Improvement in Steam Condensate Collection and Reuse Through Installation of New Steam Traps

There are 940 steam traps in Ammonia Plant 1b which have been in use for 19 years With the passage of time, the steam traps start to deteriorate and the effectiveness falls significantly The replacement of 80 defective steam traps, with 80 new traps supplied by WEC in February 1998, was a valuable opportunity to demonstrate the substantial positive result of a simple technology application for energy conservation

During the start-up of the Ammonia Plant in February 1998, measurements of steam flow were taken without using steam for heating equipment and then with the use of steam for heating A reduction in steam consumption was observed of 4 tons per hour as a result of the installation of 80 new steam traps, as reported by the plant (See Appendix A)

Since heating of equipment occurs for only 5 months per year, the resulting reduction in natural gas consumption is estimated at **1,150,000 m^3** valued at **$104,000** using a price of $90 per 1000 m^3 natural gas

IV CHRONOLOGY OF PROJECT

November 1996	-	WEC team visited plant and identified 3 demonstration projects,
August 1997	-	WEC issued purchase orders for instrumentation,
October 1997	-	Arrival of conductivity meters and steam traps for Projects #2 and #3 at Dniproazot Plant,
February 1998	-	Instrumentation for Projects #2 and #3 installed and collection of operating data initiated,
May 1998	-	Arrival of in-situ gas analyzer for Project #1 at Dniproazot Plant ,
July 1998	-	Instrumentation for Project #1 installed and collection of operating data initiated,
July 1998	-	Close-out ceremony conducted, and
August 1998	-	Final Report Issued

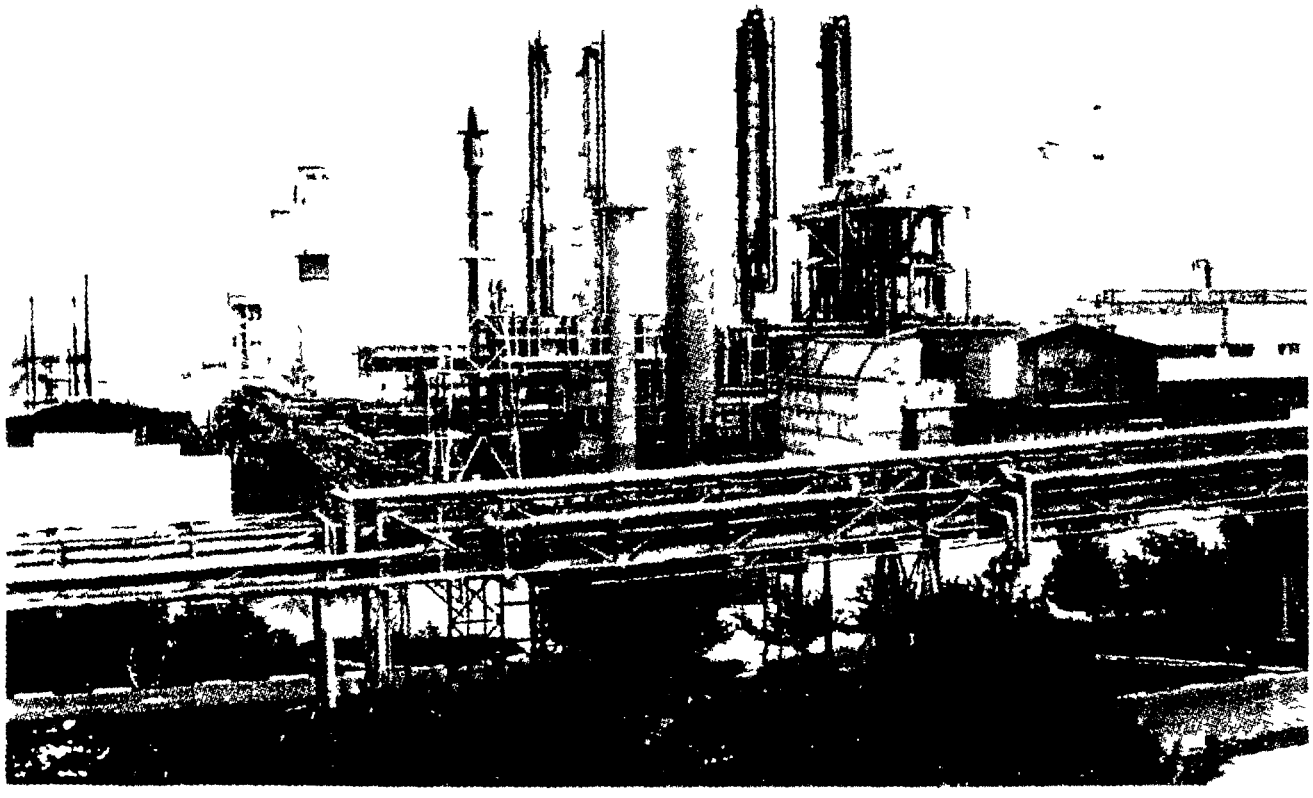
V APPENDIX A

UKRAINE

JOINT STOCK COMPANY «DniproAZOT»

REPORT

IMPLEMENTATION OF PILOT PROJECTS OF MINIMIZATION VASTES AND ENERGY SAVING



Dneprodzerzhinsk
1998 г.

According to agreement regarding cooperation between Agency of International Development USA and Ukraine it was planned to execute 3 pilot projects of WEC at JSC «DniproAzot» during 1997-98 which were directed to minimization of wastes and power saving

The purpose of implementation of the projects was to show profitability of eologically oriented activity, which was directed to reduce losses,self-cost and to improve purity of production

Table 1

AMOUNT OF INVESTMENTS AND ECONOMIC EFFECTIVITY OF 3 PILOT WEC PROJECTS

WEC investments,$	DniproAZOT investments,$	Total investments,$	Economy of DniproAZOT,$
1	2	3	4
25794	1130	26924	170553

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PROJECT 1

IMPROVMENT OF BURNING IN THE FURNACE OF HEAT-POWER STATION AFTER INSTALLATION OF GAS-ANALYZER

According to project No 1 it was planned to install the gas-analyzer to determine oxygene content into flue gas at the workshop 1-B after primary reforming

But,according to technical documentation of the gas-analyzer (series 2000 WDG-HPII/HPIIC) sensor is made in ussual form That is why it is not permitted to use the device in the buildings of B-1Г class according to explosion-proof conditions

It was defined to install the device at heat-power station according to Technical decision dated 02 07 98 ratificated by Deputy Chairman of the Board - Technical Director Mr Morokhovsky

Gas-analyzer with intelectual sensor IFT-3000,which makes measurements of oxygene content into flue gas,istalled at the boiler БКЗ-220-100Ф No 1 Primary converter of gas-analyzer is installed between steam-heater and II stage of economizer Display is installed on the control panel of smoke exhauster and ventilator of the boiler No 1

Results of gas-analyzer allow to make fast and quality regulation of gas-air proportion,to support min rate of air excess As a result, boiler efficiency increases,consumption of natural gas decreases, content of NO 4x 0 into flue gas decreases

Table 2

Cost and economic efficiency of the Project

Amount of investments,$			Economy of energy by calculat $	Planning annual gas economy, m 53 0/year	Payback time, years
WFC	Dnipro-AZOT	Total			
15222	230	15452	37126	$6,9x10^5$	0,4

PROJECT 2

Reduction of condensate losses in boiler room by means of installation of conductivity meter

Heat Power Station receives the production condensate from the workshops by three pipe-lines

Quality control of productive condensate is provided by express-laboratory of Heat Power Station To determine errors in the buildings it is necessary to have time period This may cause soiling of a general condensate with its next draining and lossing

Installation of microprocessor conductivity meters just after valves allows to instantly determine faults It is possible to avoid pollution of total condensate

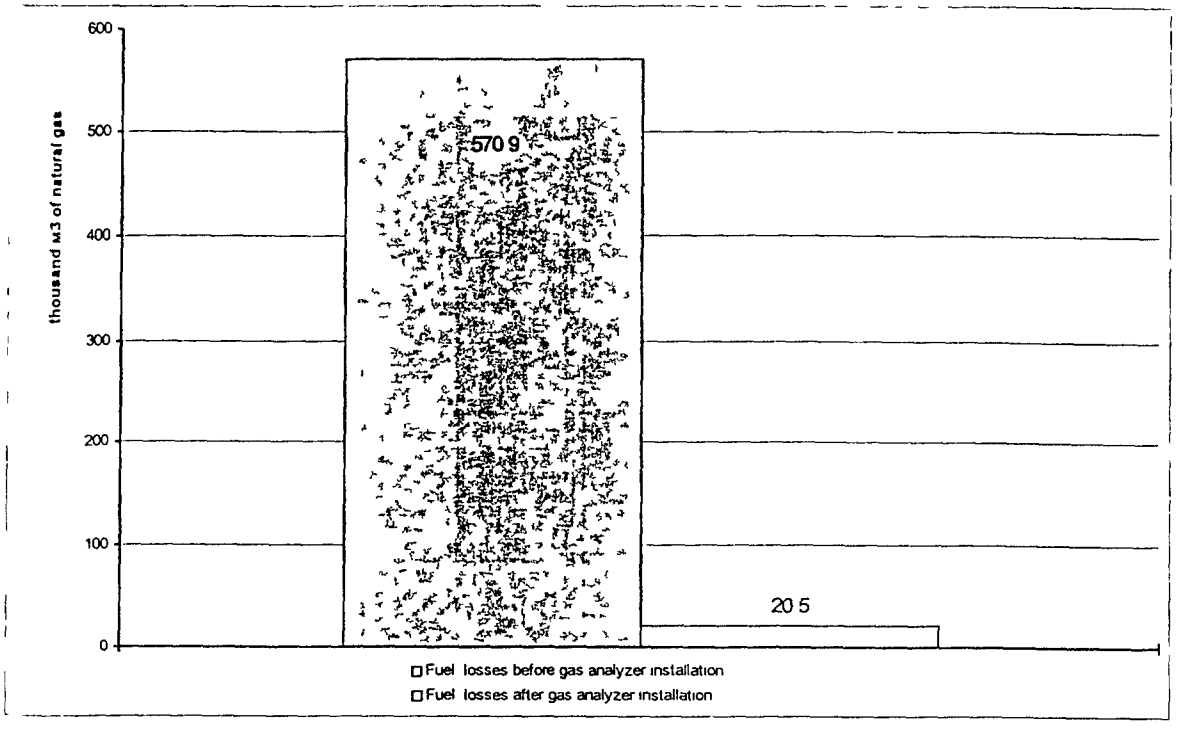
Calculation of economic efficiency -- Appendix 2

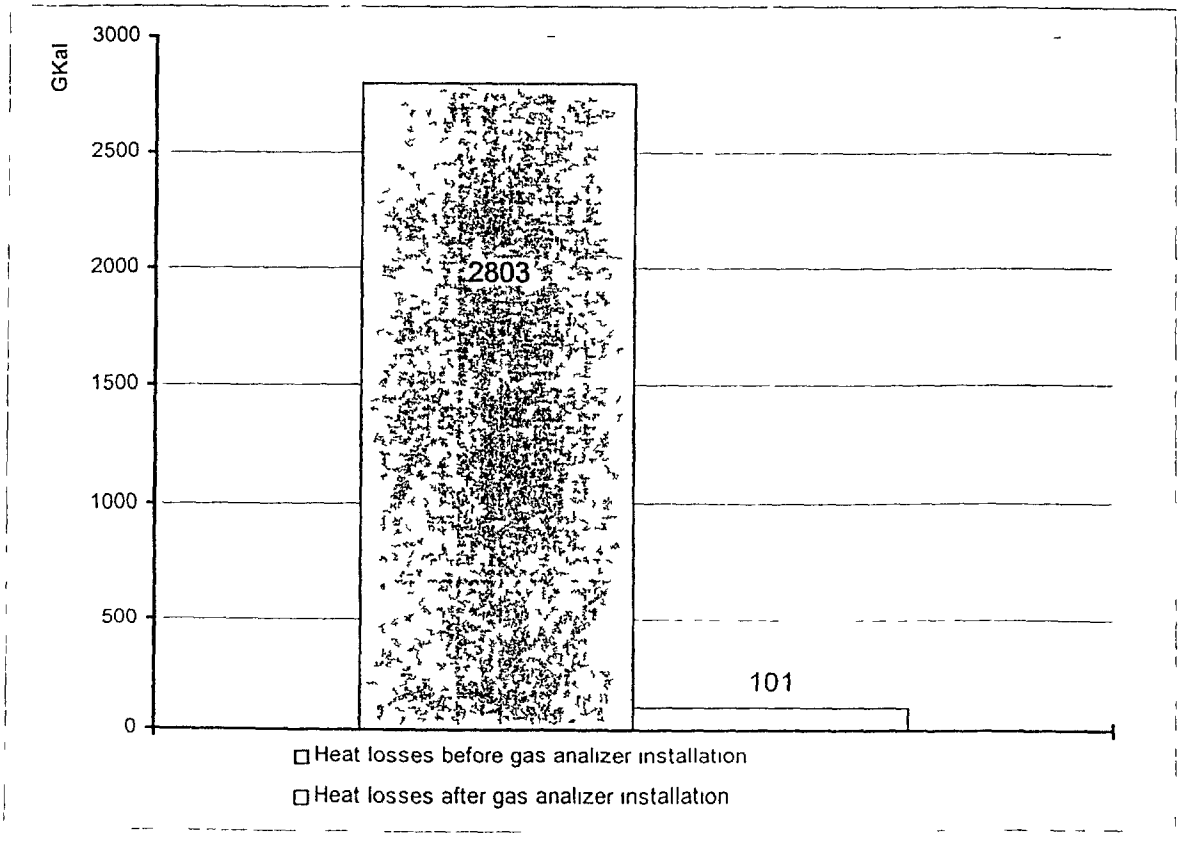
Table 3

Cost and economic efficiency of the Project

Amount of investments,$			Economy of energy by calculat $	Planning annual gas economy, m 53 0/year	Payback time, years
WEC	Dnipro-AZOT	Total			
3352	150	3502	20437	$22x10^5$	0,17

DYNAMIC OF LOSSES DECREASING FOR HEAT AND FUEL





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PROJECT No 3

Improvement of steam condensate asssembly and its repeated utilization as a result of steamtraps installation

According to this project in October 1997 JSC "DniproAzot" received 80 pc of steamtraps for installation in ammonia production

There are about 1000 steam traps in workshop N 1-b of a different steam parameters Some steamtraps went out of service within years of the workshop operation Their restoration is technically difficult And sometimes hardly possiblle Because of a bed operation of steam traps are losses of heat energy with steam This steam moves into steam traps and discharged from there to atmosphere

In the 1-st quarter of 1998 there were installed received steam traps on the lines of condensation of steam 3,5 and steam 40 on ammonia production

Calculation of economic efficiency -- Appendix 3

Table 4

Cost and economic efficiency of the Project

Amount of investments,$			Economy of energy by calculat $	Planning annual gas economy, m 53 0/year	Payback time, years
WEC	Dnipro-AZOT	Total			
7220	750	7970	112990	$12,5x10^5$	0,07

Calculation of planning economic effectivity from installation of gas-analyzer to determine oxygene content into flue gas at the boiler БКЗ-220-100Ф of Heat Power station

Before installation of gas-analyzer the losses of heat with gases at the production level of 160 mt/hour were

Q 42 0 = (Ту г - Тх в) / Т max x [С 41 0 x (h-1) x B x K] x 100%

where

Ту г = 127 5oC 0-- temperature of gases out of boiler,

Тх в = 30 5oC 0-- temperature of incoming air,

Т max -- heat of combustion with account of air moisture 5oC 0, it is equal to 2010 5oC 0 for natural gas,

B,C 41 0,K -- special rates to the equation to correct calculate heat losses

С 41 0 -- 0,826

K -- 0,79

B -- 0,8

h -- rate of volume changes for dry products of combust for natural gas

Q 42 0 = (127 - 30) / 2010 x [0,826 + (1,4 - 1) x 0,8 x 0,79] x 100 =
= 5,17 %

After gas-analyzer installation the losses of heat with gases at the same production level will be

Q = (117 - 30) / 2010 x [0,826 + (1,4 - 1) x 0,8 x 0,79] x 100 =
= 4,66 %

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Therefore, efficiency of the boiler will increase
5,17 - 4,66 = 0,51 %

92,4 % -- efficiency of the boiler before device installation

92,4 % + 0,51 % = 92,91 % -- efficiency of the boiler after device installation

According to equity of the boiler's ehat balance one could calculate consumption of natural gas in case of boiler's efficiency increasing

B x Q x K = Dn x (Iп/п - Iп/в)
where

B -- consumed natural gas,
Q -- low heat value of natural gas = 7980 Call/m 53 0,
K -- efficiency of the boiler,
Dn -- capacity of the boiler,
Iп/п , Iп/в -- enthalpy of heated steam and feed water

K = (Dn x (Iп/п - Iп/в)) / B x Q = 15420 m 53 0/hour

Therefore,economy of natural gas will be equal to

1550 - 15420 = 80 m 53 0/hour

where 15500 m 53 0/hour -- natural gas consumption at the efficiency 92,4 %

It is planning that withing a year economy of natural gas will be
80 x 24 x 364 = 691200 m 53 0/hour

Cost of 1000 m 53 0 of natural gas is 53,72 USD (at 01 07 98)
691,2 x 53,72 = 37125,9 $

Calculation of the economic effectivity from installation of microprocessor conductivity meters on technological lines of production condensate

Heat Power Station receives production condensate from workshops of the plant by 3 pipe-lines (building 120,901,962) On entry to turbine workshop after valve the pipe-lines are connected into collector and condensate moves through water heat exchanger to tank of production condensate of chemical water purification unit

Quality control of production condensate is provided by expres laboratory of Heat Power Station Condensate for analyses is choosed from special point in front of tank of production condensate In cause of norm violation of quality the express laboratory chooses condensate for analyses directly from each building After difinition of fault in given building,it is choped off by the valve For definition of faults in building it is necessary to have definite period of time,which results in soiling of general condensate with its following draining After installation of microprocessor conductivity meters just after the valves each fault is determined instantly It permits to avoid soiling and discharge of general production condensate

1 Calculation of losses of production condensate for 1997

Because of bad quality of returned condensate from production to Heat Power Station in 1997 the losses were

- building 120 C =22683 m, T=841 hour
- building 901 C =2801 m , T=132 hour

Total quantity of production condensate ,which was discharged to drainage

C =C +C =25484 m

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Losses of heat because of unreturned of condensate from production are

Q=C x (T =T)

where T п в - temperature of feed water

T р в - temperature of river water (average for year)

Q=25484 x (125 - 15)=2803 Gkal

Losses in conditional fuel are

B=Q x b

where b - specific standard of fuel rate for released heat-energy, which is equally 178,56 тут/Gkal

B = 2803 x 178,56 = 505,5 тут

Losses in natural fuel

B =B x 1,14 = 500,5 x 1,14 = 570,5 thousand m of natural gas

Consequently,damage from unreturn of production condensate is

П =Вн x Цпр г =570,5x90=$51345

where Цпр г -price of natural gas pro 1000 m for 1997

2 Calculation of real production condensate losses within March 1998 after installation of conductivity meters

After of installation of analyzers of electrical conduction the losses of production condensate were

С об 1=915 m

Losses of heating because of unreturn production condensate after installation counter of conduction in March 1998 were

Qф=Соб 1 x (Тп в -Тр в)=915 x (125-15)=101 Gkal

Losses of equivalent fuel were

Вф=Qф x в = 101 x 178,56=18 тут

In natural fuel the losses were

B=Вф x 1,14=18 x 1,14 = 20,5 thousand m of natural gas

According this calculation a damage from unreturn of production condensate with mounted analyzers of electrical conduction was

П = В x Цпр г = 20,5 x 90 = $ 1845

The economy from installation of analyzers of electrical conduction with heat regime is П=П - П =51345-1845,0=$49500

3 For a preparation of a desalted water,which is fed to boiler ВКЗ-220-100Ф,is cost price of 1000 m

Соб/в=1672 UAH/thousand m

Consequently,the expenditures from condensate unreturn for a preparation of a desalted water are

Цоб/в1=Соб/в x Соб=1672 x 25,484=42609,2 UAH

After installation of analyzer of electrical conduction the expenditures are

Цоб/в2=Соб 1 x Соб/в=0,915 x 1672=1529,8 UAH

The economy of analyzers of electrical conduction is

Ц=Цоб/в1-Цоб/в2=42609,2-1529,8=41079,4 UAH

This is to correspond to $20437 or 0,22 x 10 56 0 m 53 0/year of natural gas

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Calculation of economic effect from installation of steam traps,which were supplied by WEC for workshop 1-b JSC "DniproAzot"

At ammonia production there are 940 steam traps,which used 19 year

In the first years of unit operation a steam rate for heating was 27 mt/h After period of time a plate of steam trap becomes thinner, saddle is breaked,passes are formed and effectivity of steam traps operation decreases sharply

Consumption of steam is 3,5 atm for unit heating takes place during 5 months Thats why steam consumption is

Q = 27000 x 24 x 5 x 30 = 97200000 kg

where 27000 - steam consumption for heating per hour

24 - quantity hours per day

5 - quantity of months

30 - quantity of days in month

Consumption of steam 3,5 AT for heating of cleaning section "Karsol" takes place during 7 mounths Thats why steam consumption is

Q =1435x7x30x24=7232400 kg

where 1435 - steam consumption for heating of section "Karsol" per hour

Thus, total steam consumption with pressure of 3,5 per 1 year is

Q = Q + Q =104432400 kg

According to data of TEC and thermodynamic tables of water and steam the losses of heat with steqam may reach 0,1 % Thus, theoretical steam losses are

Q =0,001XQ = 104432,2 kg annually

Heat content of steam P=3,5 by T=100 C is 0,652 Gkal/kg
i e losses of heat are
Q =0,652x104432,2=68089,2 Gkal,
That is in money terms is
68089,2 x 19,5 = 1327735,5 USD
where 19,5 USD -cost 1 Gkal of steam or 39 UAH

There are 940 steam traps on the unit and only 80 pcs were supplied from USA,that in reletive value is 80 940 = 0,0851

Thus,economy from installation of 80 steam traps is

1327735,5x0,0851=112990,2 USD or 1255446 m3/year of natural gas

In period of the workshop initialization after its stop in february 1998 it was arranged measurements on the starting boiler without steam utilization for heating and then with shift of steam for equipment heating and "Carsol" unit Difference was 4 mt/h The economy of natural gas in recalculation for 5 months of the whole year for heating is

4800x4 60x24x30x5=1152000 m3
where 4800-m/h of natural gas for starting boiler
60 - productivity of boiler in tons

At the price of 90 USD for 1000 m3 of natural gas effectivity is-103608 USD

Thus, practically economic effectivity confirmed theoretical calculations

Prepared by department of reconstruction and development

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