

APPROVED

General Manager of

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«___» _____ 2010

Date: 08.10.2010

Fria

TEST DATA REPORT

TRGA Homogenizer on the Boiler Nr.5, Heat Station

(Period of Tests: 01.09.2010 - 01.10.2010)

(Boiler 5: model БК3-160 -9,8-490М, Manufacturer: OJSC «ENERGOMASHCORPORATION», Russia;
Output: 160 tons per hour; superheated vapor temperature 490 C°; superheated vapor pressure 100 Bar.)

I. Purpose of Test

1. To improve the fuel oil combustion in the boiler 5.
2. To achieve the fuel saving in the boiler 5.
3. To develop on the ground of the positive results the installation schedule of TRGA in other heat station boilers and in the factory kilns in order to reduce the fuel consumption as well as the risks at use of the quality-limited fuel oil.

II. TRGA homogenizer installation on the boiler 5

1. TRGA-2-15G fuel oil homogenizer (operating pressure up to 40 Bar, maximal output 15 tons of fuel oil per hour) was selected for testing jointly with the equipment manufacturer. These specifications fully correspond to those of the fuel oil supplied to the boiler 5.
2. The fuel oil homogenizer was installed by the heat station maintenance personnel on the fuel oil supply line to the boiler injectors in the line's straight part, behind the fuel oil pressure controller and in front of the injectors. (*Figures 1, 2*)

Figure 1 *Installation of homogenizer on the boiler 5*



Figure Nr.2 Installation of homogenizer on the boiler 5



- When mounting the actuator provides tripping valves, bypass line with valve and a line for steam cleaning of the activator from the collector auxiliary boiler. The installation is performed in correspondence with the diagrams. (Figures 3, 4)

Figure Nr.3 Installation diagram of the homogenizer on the boiler 5

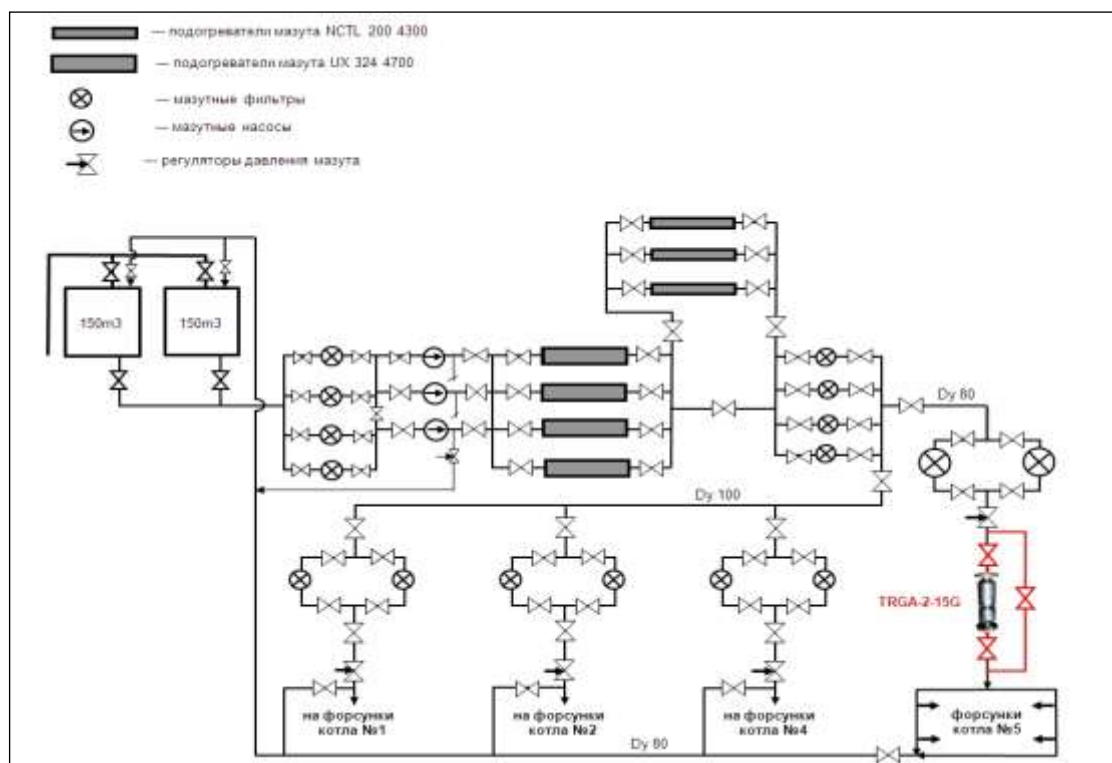
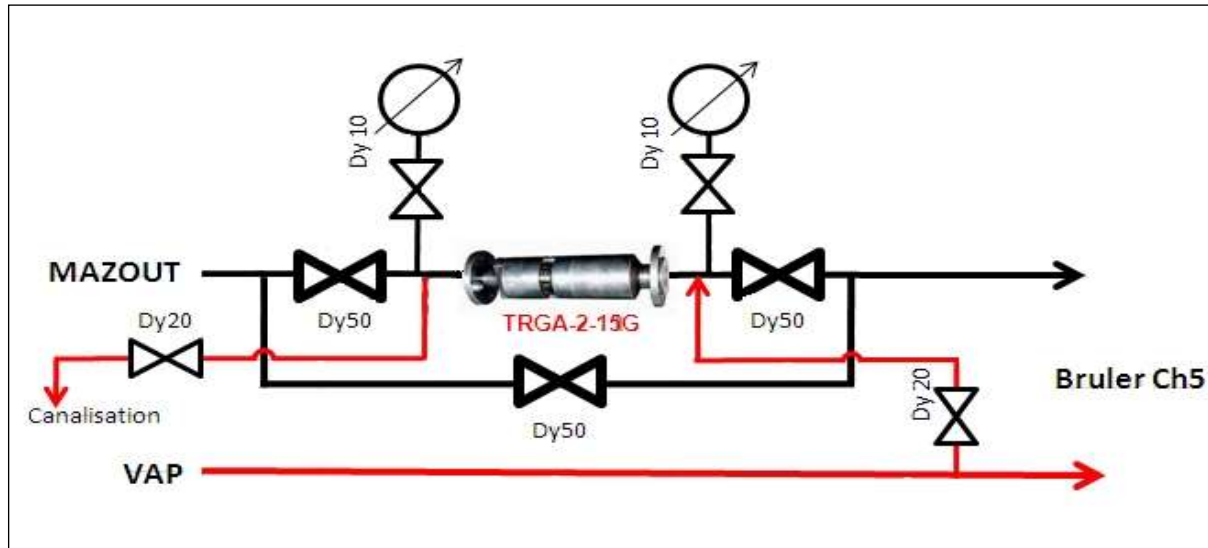


Figure Nr.3 Installation diagram of Homogenizer TRGA-2-15G



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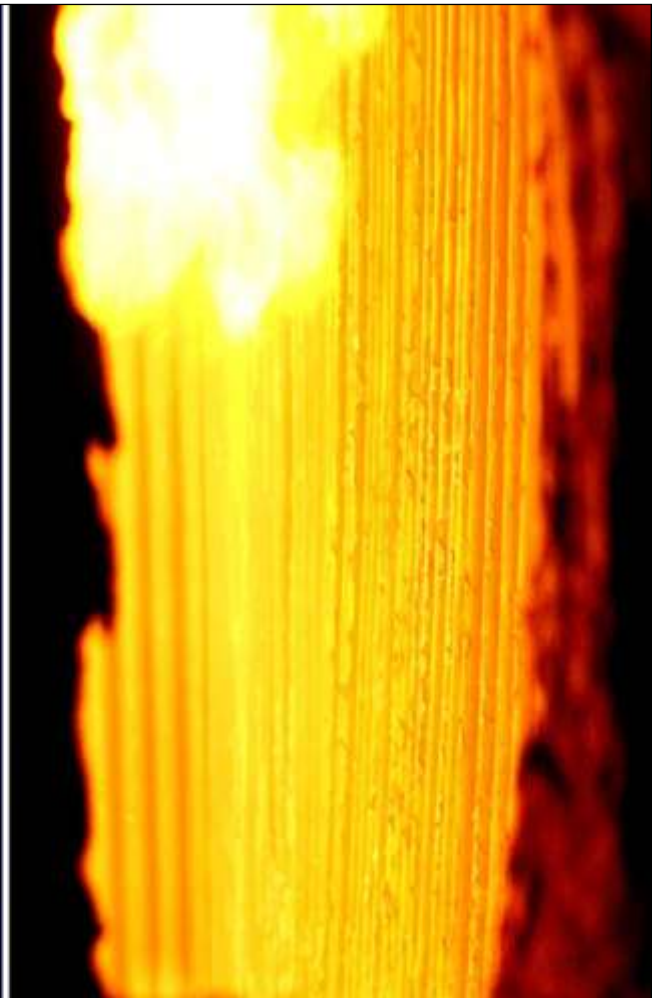
II. TRGA Homogenizer Tests Procedure.

As soon as all preliminary works are terminated, on 02.09.2010 the boiler 5 started its operation with the fuel oil supply through TRGA-2-15G homogenizer. The injectors' ignition was trouble free. The fuel oil combustion was very bright, and no black smoke was seen in the furnace even in the beginning of the combustion, when the boiler furnace is not heated. Such combustion is normal when diesel fuel is generally used. (Figures 4, 5)

Figure 4



Figure 5



The combustion in the boiler 5 was supervised after one day. The boiler's output at operation was 120 tons of steam per hour, what is equal to 75% of the rated load. The fuel oil combustion was very even, the flame body plasma was «smooth», no «licking» of the front and rear screens was observed; no grey smoke signs were seen in the furnace. In the course of the combustion supervising the upper part of the furnace (+14,6m mark, by 6m above the furnaces) was completely smoke free; and all heated surfaces were seen through the inspection window. (Figures 6, 7)

Figure 6

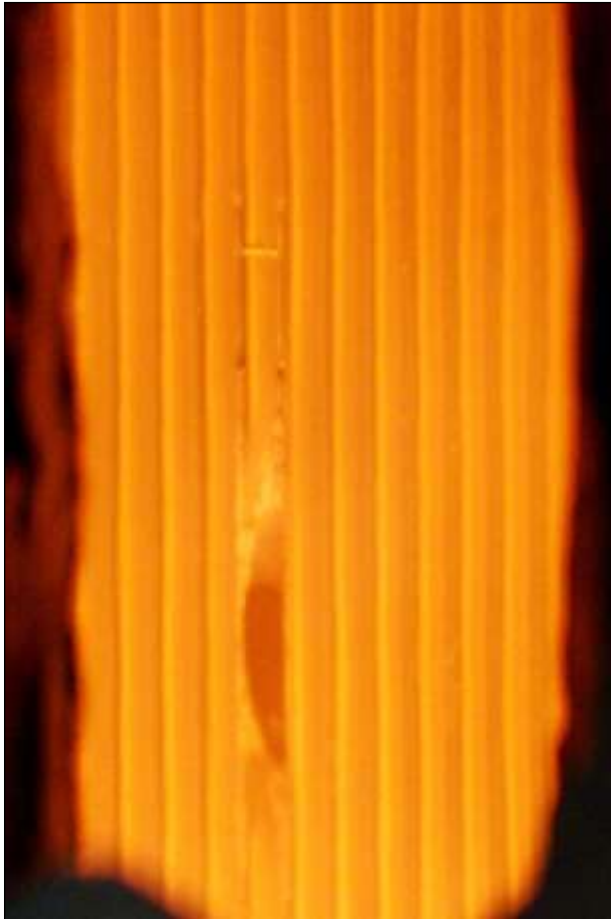


Figure 7



During one month the boiler was operated on the fuel oil treated with TRGA-2-15G homogenizer. The homogenizer was cleaned with vapor just once, for the prevention purposes only. No pressure difference occurred in the course of testing, its value was equal to **P = 1bar**.

The heat station's staff registered the daily vapor generation and fuel oil consumption one month before testing as well as during the testing. They also monitored the specific value of the fuel oil consumption per one ton of generated vapor for the further analysis of the testing results.

On 01.10.2010 at 9.15 a.m. the boiler 5 was shut down. As soon as the boiler is cooled, the boiler furnace, convection shaft's heating surfaces and tubular air heater's surfaces were inspected for the purposes of the testing results analysis.

IV. TRGA Homogenizer Testing Results.

1. TRGA-2-15G homogenizer mounted into the fuel oil supply system to the boiler 5 enabled reduction of the fuel oil specific consumption required for one ton of superheated vapor generation. It is obvious from the boiler instrument instantaneous readings that after the homogenizer installation the fuel oil specific consumption required for vapor generation was reduced during the testing period to the max. value 7,936 kg/ton. (Figures 8,9,10)

Figure 8 Instrument readings before the homogenizer installation

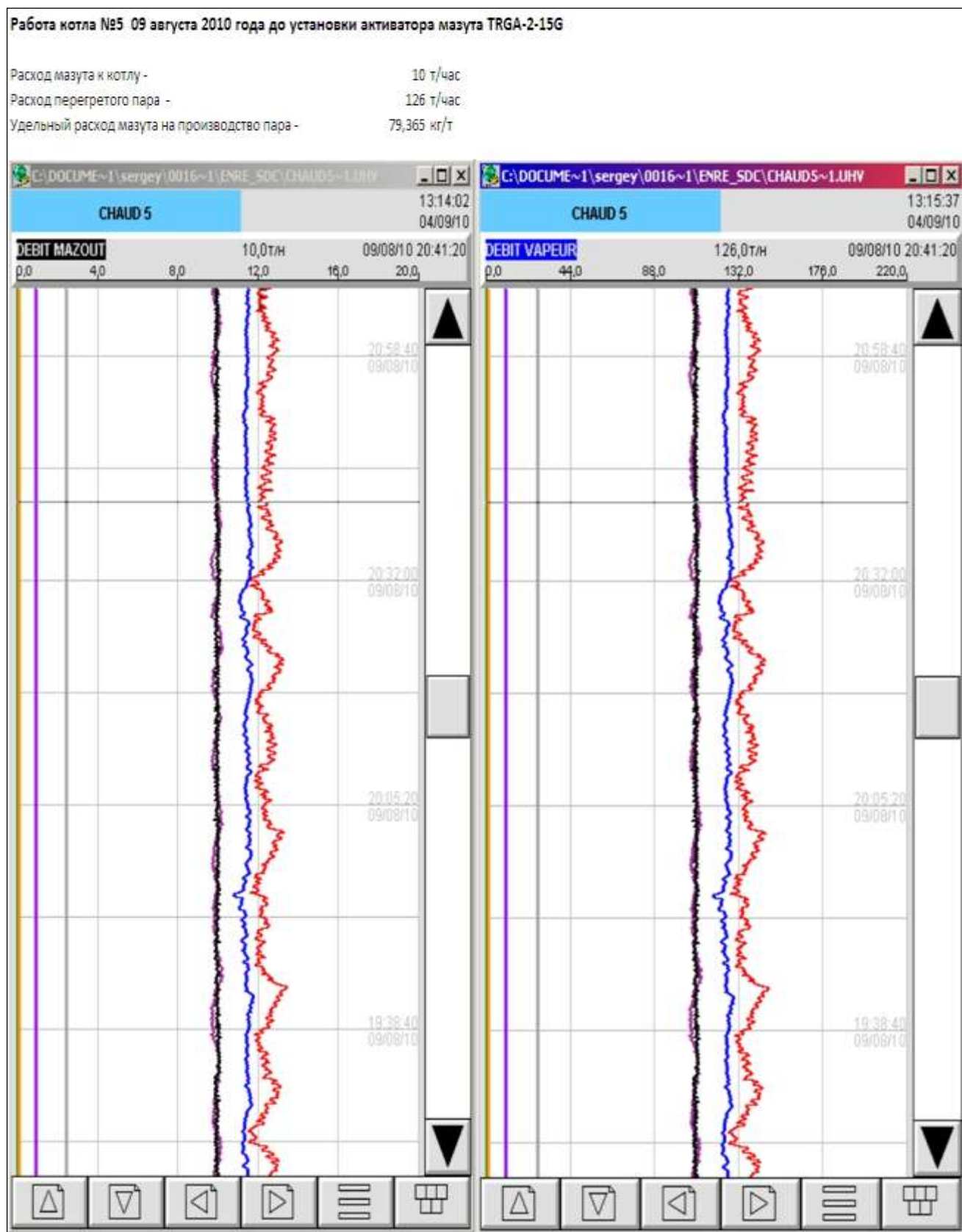


Figure 9 Instrument readings in the first days of testing

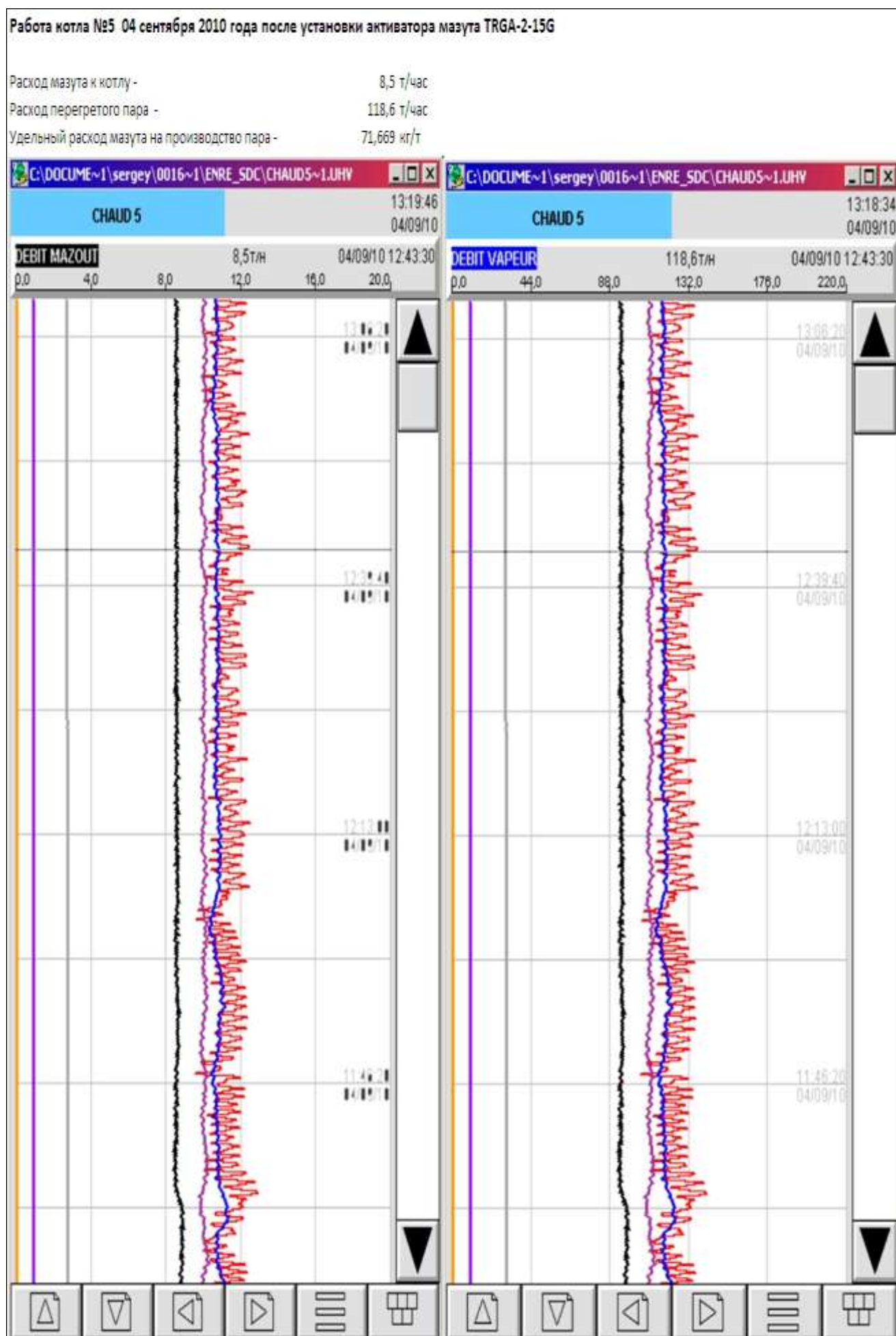
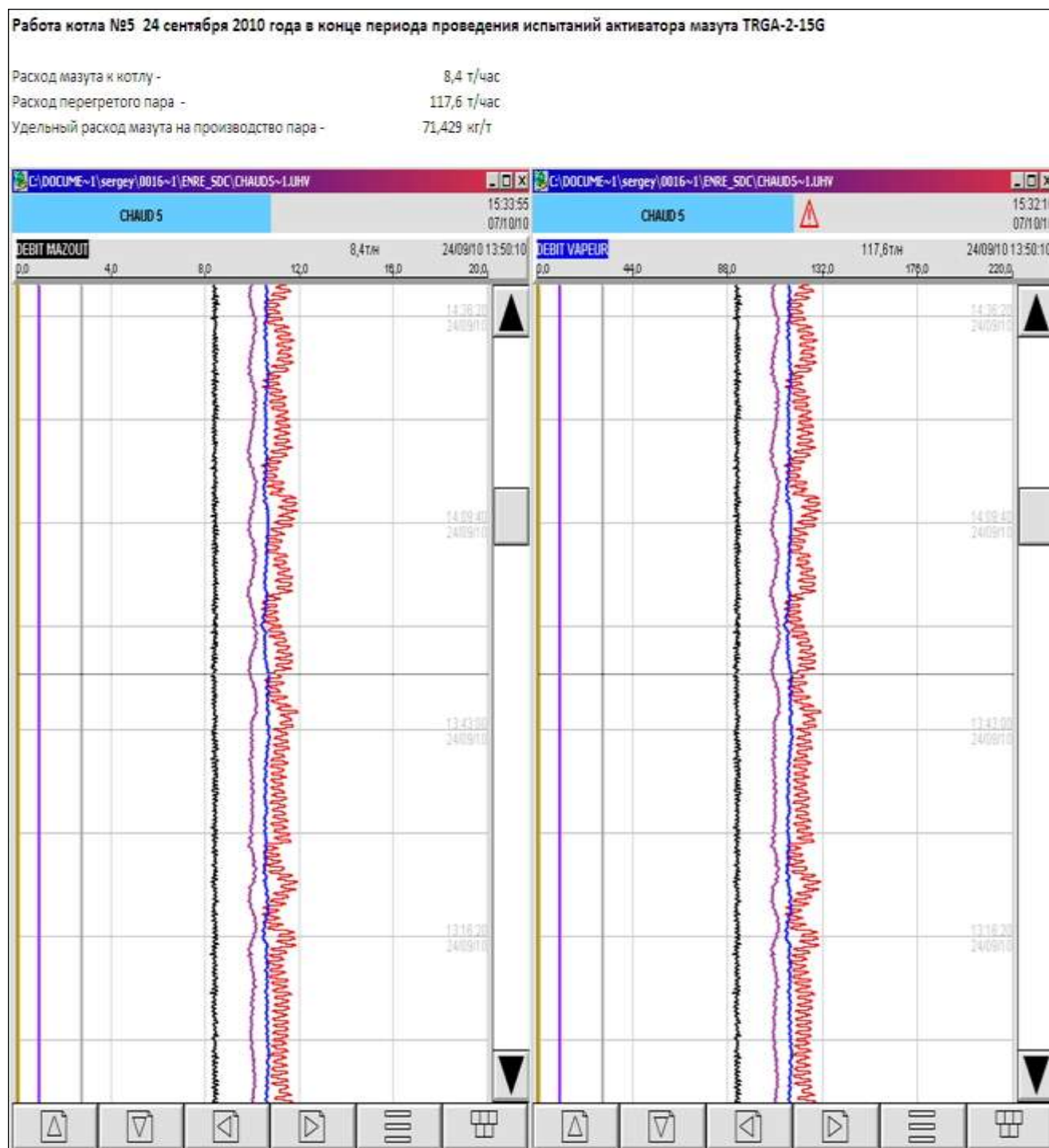


Figure 10 Instrument readings in the closing stage of testing



For the purposes of more detailed analysis the superheated vapor generation and fuel oil consumption were registered daily on the boiler 5. The information was recorded in the special register. The superheated vapor generation and fuel oil consumption measurements and calculations were performed by «Honeywell» - the automated control system of the boiler.

The boiler operation data recorded in August 2010 in the standard operating conditions without homogenizer and the data of September 2010 when the boiler was supplied with the fuel oil treated with TRGA-2-15G homogenizer were analyzed for the purposes of comparison.

The comparative analysis of the two months data demonstrates that TRGA-2-15G homogenizer use on the boiler 5 reduced the fuel oil rate of use by 2,994 kg/ton (or 4.1%) on average (see Table 1).

The results of testing proved TRGA-2-15G homogenizer operability, as well as its availability for the purposes of the fuel saving and cost saving.

Table 1. Comparative analysis of the boiler operation in standard mode and when the homogenizer was used.

Показатели до установки гомогенизатора TRGA-2-15G				
Date / дата	CHAUD-5 / котел №5			
	mazout / мазут		vapeur/ пар (t)	cons.spécifique / удельный расход мазута (кг/t)
	(m3)	(t)		
01.08.2010	206	198,8	2739	72,578
02.08.2010	205	197,8	2733	72,384
03.08.2010	206	198,8	2743	72,472
04.08.2010	206	198,8	2748	72,340
05.08.2010	205	197,8	2708	73,052
06.08.2010	205	197,8	2711	72,971
07.08.2010	208	200,7	2752	72,936
08.08.2010	212	204,6	2734	74,828
09.08.2010	228	220,0	2848	77,254
10.08.2010	214	206,5	2780	74,284
11.08.2010	212	204,6	2730	74,938
12.08.2010	203	195,9	2623	74,684
13.08.2010	205	197,8	2692	73,486
14.08.2010	211	203,6	2780	73,243
15.08.2010	208	200,7	2742	73,202
16.08.2010	197	190,1	2480	76,655
17.08.2010	205	197,8	2675	73,953
18.08.2010	214	206,5	2782	74,231
19.08.2010	216	208,4	2824	73,810
20.08.2010	198	191,1	2594	73,658
21.08.2010	216	208,4	2868	72,678
22.08.2010	215	207,5	2834	73,209
23.08.2010	214	206,5	2821	73,205
24.08.2010	148	142,8	1947	73,354
25.08.2010	Остановка котла и монтаж гомогенизатора			
26.08.2010				
27.08.2010				
28.08.2010				
29.08.2010				
30.08.2010				
31.08.2010				
Mois /месяц	4957,0	4783,5	64888,0	73,719

Показатели после установки гомогенизатора TRGA-2-15G				
Date / дата	CHAUD-5 / котел №5			
	mazout / мазут		vapeur/ пар (t)	cons.spécifique / удельный расход
	(m3)	(t)		
01.09.2010				
02.09.2010	84	81,1	1006	80,577
03.09.2010	207	199,8	2866	69,698
04.09.2010	211	203,6	2904	70,115
05.09.2010	214	206,5	2939	70,265
06.09.2010	221	213,3	2954	72,195
07.09.2010	221	213,3	3025	70,501
08.09.2010	220	212,3	3016	70,391
09.09.2010	219	211,3	3003	70,375
10.09.2010	219	211,3	3017	70,048
11.09.2010	217	209,4	2997	69,872
12.09.2010	220	212,3	3014	70,438
13.09.2010	221	213,3	3030	70,384
14.09.2010	221	213,3	3026	70,478
15.09.2010	219	211,3	2998	70,492
16.09.2010	209	201,7	2784	72,444
17.09.2010	145	139,9	1957	71,500
18.09.2010	Аварийная остановка котла из за порыва экранной трубы заднего экрана топки			
19.09.2010				
20.09.2010				
21.09.2010				
22.09.2010	172	166,0	2270	73,119
23.09.2010	201	194,0	2778	69,822
24.09.2010	202	194,9	2798	69,668
25.09.2010	200	193,0	2764	69,826
26.09.2010	199	192,0	2733	70,265
27.09.2010	200	193,0	2714	71,113
28.09.2010	201	194,0	2749	70,558
29.09.2010	203	195,9	2684	72,986
30.09.2010	200	193,0	2703	71,402
Mois /месяц	4242,0	4093,5	57879,0	70,726

Среднее снижение удельного расхода мазута на тонну произведенного пара на котле			2,994 кг/t
			4,1 %
Фактические показания параметров измерялись штатными приборами входящими в нижний уровень АСУТП котла: - расход перегретого пара (ANUBAR) - расход мазута (KROHNE UFM 3030K/2MHz) Расчет посуточных величин производился верхним уровнем системы АСУТП котла " Honeywell".			

2. At TRGA -2-15G homogenizer use the more complete fuel oil combustion, essential reduction of carbon sediments on the boiler's heating surfaces and almost complete sulfur burn-up were achieved. When the boiler was shut down, all heating surfaces were examined thoroughly. The results of the heating surfaces inspection of the boiler 5 after TRGA-2-15G fuel oil homogenizer use are as follows:

- There is some light brown ash deposit on the boiler furnace tubes. The tubes are free from any carbon sediment (*Figure 11*);
- The platen superheater is clean; some small signs of slag are available. The tubes are free from any carbon sediment (*Figure 12*);
- The convection shaft heating surfaces are clean. There is some light brown ash deposit on tube banks of the 1st and 2nd stage economizer. The tubes are free from any carbon sediment (*Figure 13*);
- The tubular air heater is clean; the inside of the tubes (exhaust gases passageway) is covered with a thin layer of light brown ash deposit. The dead spaces include a small amount of carbon sediment (*Figure 14*);
- All heating surfaces of the boiler are completely free from any yellow and green sulfuric oxides, which were always available on the heating surfaces before the homogenizer use.

Figure 11 The boiler furnace at burners level



Figure 12 Platen superheater

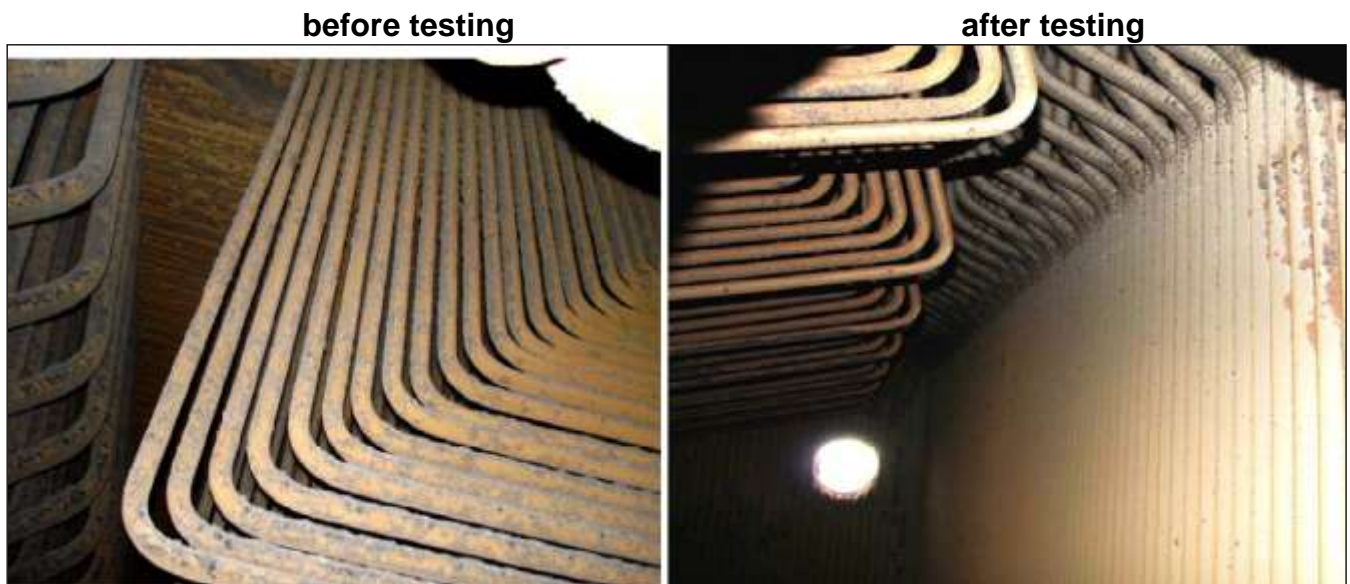


Figure 13 The 1st stage economizer



Figure 14 Tubular air heater



The testing results confirm that TRGA – fuel oil homogenizer – use improves the fuel combustion and reduces significantly the carbon sediment formation. The homogenizer installed on the boiler guarantees a long period of operation without use of the shot blasting system on the heating surfaces, what in its turn saves power consumption, as the shot blasting compressors are not used at that.

Note: TRGA homogenizers installed on the heat station's boilers, diesel generator sets and kilns enable to reduce the risks in the event of use of the cheaper quality-limited fuel oil in FRIGUIA SA.

Director for Power Supply

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(The original document in Russian – we can send your request, subject to providing a business card of your enterprise)

Attachments

Fuel.

Trafigura Limited

Att. Mrs. Selma Bodvards

Nr. : 10404/00013366/10 – Page 1/1

Date : July 21, 2010



Product : Fueloil
Vessel : mv."Torm Fox"
Location: : Petronor Bilbao

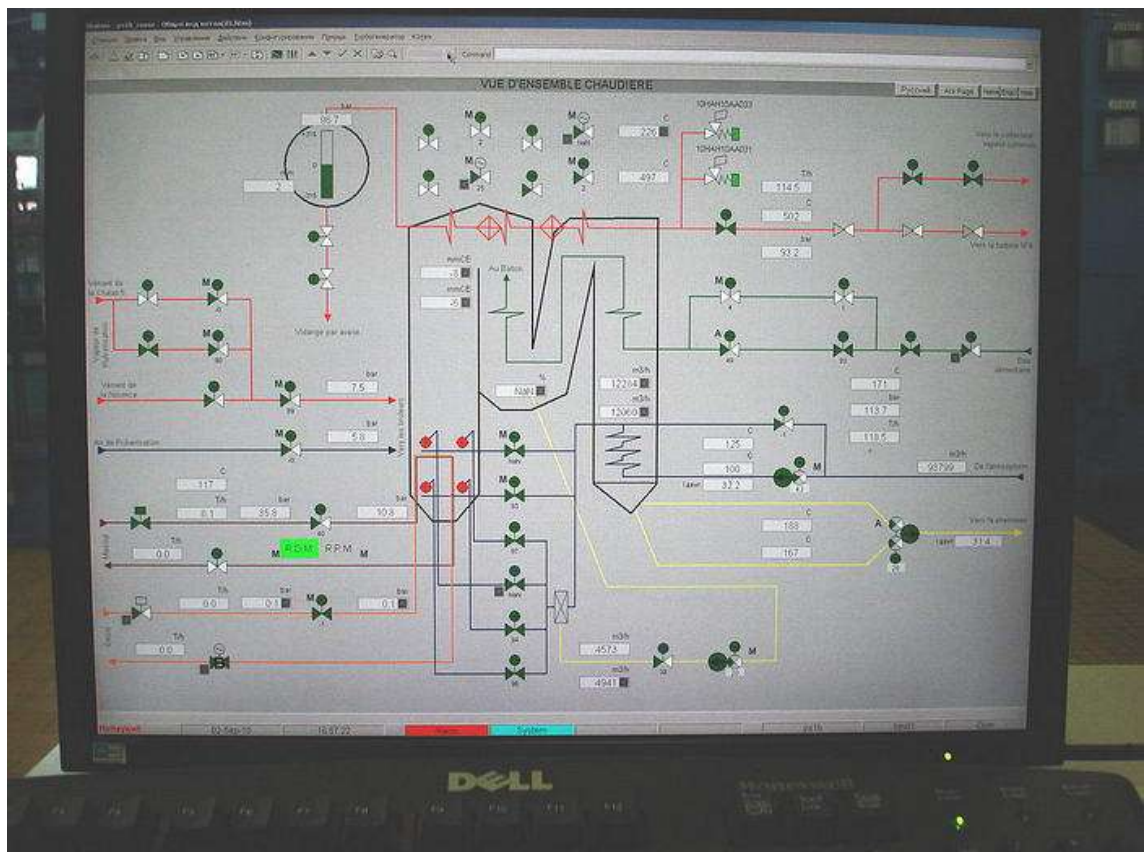
Test	Unit	Method	Results
Density at 15°C	g/ml	ASTM D-4052	0.9893
Sulphur	%m/m	ASTM D-4294	2.55
Viscosity at 50°C	cSt	ASTM D-445	357
Flash Point PM	°C	ASTM D-93	78
Pour Point	°C	ASTM D-97	-12
Vanadium	Mg/kg	ASTM D-5863	201
Vanadium + Sodium	Mg/kg	ASTM D-5863	234
Sodium	Mg/kg	ASTM D-5863	33
Water by Distillation	% v/v	ASTM D-95	0.10
BSW	% v/v	ASTM D-1796	<0.05
Aluminium + Silicon,	Mg/kg	IP 377	16
Hydrogen Sulphide	mg/kg	IP 399	<2
Asphaltenes,	%P	IP 143	9.3
Gross Specific Value (Calculated)	Btu/US gal	ISO 8217+calc	151225
Shell Hot Filtration Test	%m/m	SMS 2696	
Existent Dry Sludge			0.05
Accelerated Dry Sludge			0.04

Analysis run in external lab.



www.afuelsystems.com/ru/trga/s46.html





We thank management for the opportunity to demonstrate the specifications of our homogenizer - TRGA-2-15G on the boiler БК3-160 -9,8-490M, equipped with FRESA - the most advanced injectors made in Russia.

We thank Mr. S.A. Shlyaga, Director for Power Supply for his punctuality, diligence and consistency, beginning from the thoroughly filled questionnaire and finishing the continuous and objective monitoring of all changes detected during the testing, as well as for the photos of all results.

A half-year correspondence including the place of homogenizer installation and homogenizer type, the details of operation on a certain object, similar situations analysis and a great number of questions – all for the purpose to ensure the safe and effective operation of our equipment – preceded the tests.



The homogenizer mounting, complete cycle of its testing, documentation and photos of the results are made by the Company's staff under the direction of Mr. S.A. Shlyaga, Director for Power Supply

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You probably may be interested in some extracts from the letters:

«In the event if the activator provides us with another effect – i.e. excluding of the carbon particles sedimentation on the heating surfaces of the convection shaft as well as on the air heater, then it shall mean a new approach to the boiler design, especially the cleaning system (a sootblower or shot blasting system) installation on fuel oil boilers may result unnecessary. It's a very important supplement to a simple of fuel oil reduction. Actually, the testing will prove. »

*“30 minutes ago we ignited the fuel oil injector on the boiler 5. Our first impressions:
- ignition with the electric fuse was trouble free and was made from the very first;
- the flame light in the cold boiler looks like the diesel fuel combustion;
- almost no black smoke;
- flame opening angle on the furnace is smaller in comparison with the fuel oil combustion without activator;
- with one working injector and ignition mode there is no pressure difference in the activator, the fuel oil pressure is maintained within the limits 10 bar .”*

“1. There were some faults during the boiler ignition without activator. Sometimes fuel oil could not start burning at once, we needed the additional attempts.

2. Naturally, we washed the boiler before its startup and all heating surfaces, thus no black smoke could be seen at once.

On the other hand we shall be able to evaluate the sediments availability, as well as their quantity during the boiler operation with the activator.

3. Unfortunately our injectors are not new, instead they are rather worn out, though the same injectors worked without any activator.

4. Despite of the reduced angle of the flame angle opening, the flame length is not enlarged significantly. However the flame length enlargement cannot cause any great harm, as the injectors are situated on the lateral screens, opposite each other in two levels.

Injector 1 is opposite injector 4 (bottom level), injector 2 is opposite injector 4 (upper level). With the flame length enlargement the super heated vapor temperature may also grow a little bit, for such a case we have two stages of vapor coolers for adjustment purposes.

The main thing: the flame shall not lick the furnace front and rear screens. Nothing of the kind is observed.”

“The first data confirms the reduction of the fuel oil consumption. Though the instantaneous data are not suitable for the operation evaluation, due to the constant fluctuations of boilers and turbines operation. There are certain vapor pressure changes in the main vapor conduit, affecting slightly the vapor consumption per boiler. That is why daily values suit better for the efficiency evaluation; since all daily values of fuel oil consumption and vapor generation are computed automatically.”

“I have examined the boiler today again. The activator still works.

1. The fuel oil pressure in front of the activator is 12 Bar, and after the activator is 11,2 Bar. The resistance is less than 1 Bar. The fuel oil temperature is 118 C°.

2. The fuel oil consumption is 8,5 m3/hour; superheated vapor consumption is 118 ton/h per one boiler.

3. The general flame plasma in the furnace is "smooth" and very even. The flame almost does not lick the furnace front and rear screens. The furnace is well within view. All screens and platen superheater, hanging over the furnace, are clearly seen in the upper part of the furnace. No flame separation (looks like small flies) is observed.

4. The smoke from the chimney is slightly blue, it looks like solar oil combustion.

I believe all previous sediments from the heating surfaces (which we failed to remove) shall separate and burn off after one week in this mode. If it happens, we shall get a very good result.”

“In brief - the activator works. The certain saving is available. The activator use enabled the secondary air supply reduction necessary for combustion, and the fuel combustion is almost complete.

The activator works with almost no cleaning. My employees said that they had treated the activator with steam before the boiler startup after the emergency shutdown for preventive purposes only. The vapor pressure difference – 1 Bar – was the same both before and after the vapor treatment. Concerning the heating surfaces contamination - we plan to shut down the boiler tomorrow (there are some defects), and I shall perform the complete examination and make photos of the convection shaft's and air heater's heating surfaces – and everything will become clear at once.”

“I shall draft and forward you a complete report of tests probably till the end the next week. We shut down the boiler today; it will be cooled during Saturday and Sunday; on Monday I shall perform the complete inspection, make photos, and all materials will be completed.

As for homogenizers, I realize after the testing that all information in Internet about 10% saving is the exaggeration. 10% is such a great value, which can be economized due to a miracle only or fuel changed calorificity (the basic fuel component affecting its consumption)”

“Today I have inspected the boiler and all heating surfaces, and I must say in this connection that TRGA operation is very effective. We have got everything we planned from this device. It enabled 3%

fuel saving, being it a considerable value of saving, which is actually attainable. The sediments on the boiler's heating surfaces are really reduced: the furnace screens are practically clean, no carbon sediments are available; no carbon sediments are available in the convection shaft; there are some carbon sediments in the tubular air heater, though their quantity is 10 times less and they are concentrated in the dead areas only, while the tubes, through which gases are discharged, are absolutely clean.

There is a slight slogging in the wick area (tubes evacuation on the furnace outlet), as well as on the upper part of the super heater units in the convection shaft (it is just the place of the wick in the gases direction). The gas temperature in these areas is 900-1200 C°. I believe that all alkali metals contained in the fuel oil start to deposit there. But it's not a big deal, as the structure of all slag is rather fragile, so it can be easily removed.

But there were no such kind of sediments before; the available slag was rather hard. Besides that all sulfur burns out completely, as there are no signs of the latter in the boiler. All surfaces were covered with yellow and green deposit before. Well, we are going to wash the boiler. If the water is not green this time, then all sulfur burns out."

«I am more interested in the operation of the equipment accompanied with this device, and its influence on various indices. See the example as follows:

The operation of boiler 5 without any activator, output - 120 ton per hour, required 100 000m³ ... 110 000m³ of air supplied through the blow fan to achieve the complete combustion and to make the smoke from the chimney lighter.

Actually for the operation with output 120 ton per hour where the activator is involved we supply 95 000m³ - 97 000m³ of air only; and we achieve good combustion of fuel free from any dark smoke. This results in the reduced heat loss for its heating due to the reduced air supply. Unfortunately as only oxygen (maximal quantity in the air is 20%) is involved into burning, all assist gases are to be heated as well. Therefore with the reduced air supply, the stable combustion quality thanks to the activator – the boiler's efficiency is improved. Naturally, this opinion is based on the visual observations only; though the commissioning tests with all required instruments should probably prove this data."

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TRGA-2-15G Homogenizer on Boiler 5

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