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UYGULAMA KONULARI

CONVERSION OF A DOMESTIC FUEL-OIL BURNER INTO A NATURAL-GAS BURNER*

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ÖZET

Türkiyenin önde gelen ve geniş imalat programı içinde sıvı yakıt brülörlerininin de yer aldığı bir özel sektör kuruluşu, daha önce satılmış ve halen kullanılmakta olan sıvı yakıt brülörlerinin az bir değişiklikle doğal gaz brülörüne dönüştürülmesinin mümkün olup olmadığının araştırılmasını istemiş, böylece doğabilecek tasarruftan doğal gaza dönüşüm isteyen müşterilerini de yararlandırmayı düşünmüştür.

Yapılan çalışmalar sonucunda bunun mümkün olduğu, gerekirse acil gereksinim halinde brülörlerin çok kısa bir sürede tekrar sıvı yakıt brülörüne dönüştürülebileceği fiilen gösterilmiştir.

SUMMARY

One of the leading companies of Turkey, manufacturing among others domestic type of fuel-oil burners, wanted to convert their previously sold burners which are already in service, with a minimum of cost and effort into natural gas burners.

This has been achived and the burner tested. The results shown that the converted burner complies with european standarts.

INTRODUCTION

One of the leading companies of Turkey, manufacturing among others domestic type of fuel-oil burners, wanted to convert their previously sold burners which are already in service, with a minimum of cost and effort into natural gas burners, such that their former customers now converting to natural gas and the company itself could share the profit thus obtained.

This has been achieved by replacing the fuel injection nozzle with a newly designed natural gas burner head to fit in the available space, adding a screen to bring the excess air to the required level, replace the turbulator with a better design, add a train of spherical valve, fiiter, pressure regulator and sensors and replacing the starter-regulator control unit with a proper one for natural gas.

THE ORIGINAL BURNER

The original burner has been designed for a capacity of 150.000 kcal/h which corresponds to 175 kW. We had to design the natural gas burner for a maximum of 120 kW heating capacity, because this limit has been set as the upper limit for natural gas burners starting by direct ignition without a pilot flame according to German standarts.

The fan capacity was greater then needed. The butterfly valve available was kept for later fine adjustment purposes and an airflow reducing screen had to be designed as will be explained later.

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** *Yazar önceki sayılarımızda tanıtılmıştır.*

The fuel-oil pump driven by the fan motor was kept in its place for later use if necessary, only a clutch connecting it to the motor had to be removed to prevent dry running of the pump.

The electrical ignition system and the turbulator were kept in their original places. Later during test runs, as a single discrepancy it was found out that the %CO in the products of combustion was much above the allowed upper limit. The cause of it was the poor functioning of the original turbulator, so a new, more effective one had to be designed and tested.

The only irrevocable operation done on the original burner was a hole bored on the right side of its main body to pass a 3/4 inch pipe to supply the fuel gas. This hole can be closed by a plastic stopper, as some holes were already deleted by the use of this method, in case the burner would be reconverted into a fuel-oil burner.

THE DESIGN PROCEDURE

First, the pressure difference to volume flow rate characteristic curve of the blower had to be determined by experiment. This information was necessary for the design of an air flow restriction screen. This way we have discovered that the excess air supplied with liquid fuels is not very precisely controlled and usually kept at excessively high values. With natural gas the excess air has to be kept under control within narrow limits, not only because the standarts require it that way but because it causes uncontrolled combustion and may even cause explosions. After the design was completed and the newly designed components manufactured and mounted on the burner, we have tried to run it without the air flow restricting screen. The lean mixture caused immediate burn-outs and subsequent automatic restarts. The air flow controlling screen is shown in (Figure 1).

THE BURNER HEAD

The design criteria for the burner-head is the necessary volume flow rate of natural gas such that it will release the 120 kW heat energy at a gas delivery pressure of 20 millibar against a back pressure of 4 millibar. Given data is the analysis of the Siberian natural gas and its guaranteed heating value, which was as follows:

Component		Chem.Comp.Mole %		
Methane	CH_4	min.	85	%
Ethane	C_2H_6	max.	7	%
Propane	C_3H_8	max.	3	%
Butane	C_4H_{10}	max.	2	%
Pantane and	C_5H_{12}			
other heavy CH		max.	1	%
Carbon dioxide	CO_2	max.	3	%
Oxygen	O_2	max.	0.02	%
Nitrogen	N_2	max.	5	%
Total Sulphur		max.	102	mg/m^3
Higher Heating Value		max.	10.9	kW/m^3
		min.	10.2	kW/m^3

After going through some literature and logical decisions, a gas analysis which would add up to 100% was decided on, where the molar percent of the methane gas was taken as 92%. Calculating the molecular mass of this representative gas, the higher heating value of it was calculated to be HHV = 37.900 kJ/kg gaseous fuel. We had to calculate the heating value, because the natural gas was not yet available at the University's laboratories as we started with the project.

With gas burners using 20 mbar gas pressure, up to a capacity of approximately 200 kW, 3/4 inch piping is used for gas delivery to the burners, we have followed

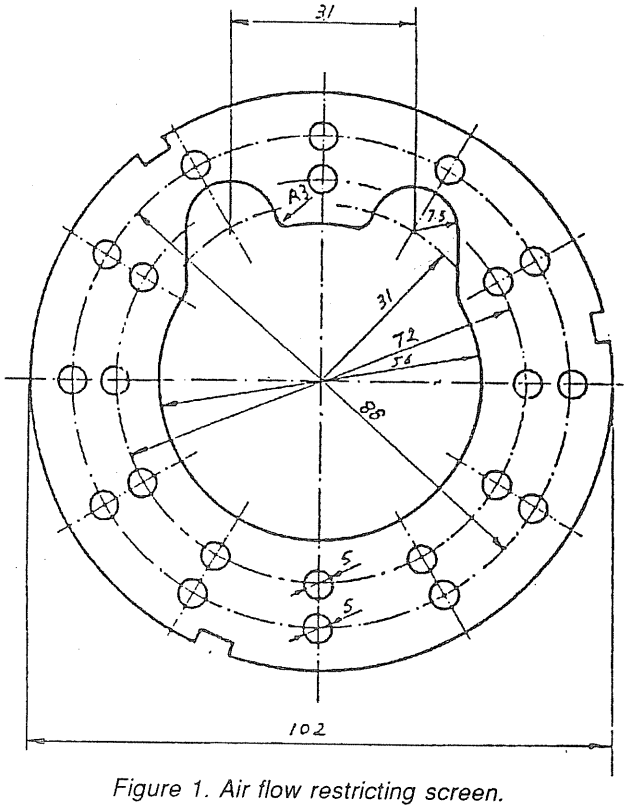

Figure 1. Air flow restricting screen.

the same line. The burner head had to be such that it would be easily mounted on this 3/4 inch pipe, be simple in construction, easy to manufacture and handy for cleaning purposes. More important was that it should provide a very good mixing of the fuel gas and combustion air. A literature survey indicated clearly that gas nozzles should have diameters not less then 3 mm and not more than 5 mm. The one under consideration being the smallest gas burner, our decision fell on 3 mm diameter holes.

Next a balance between the number and shape (nozzle shape factor) of nozzles had to be reached. A first rough calculation indicated the necessity of 11 holes, so we decided on 12 nozzle holes, each at an angle of 30 degrees on the periphery of a 15 degree inclined annular surface (Figure 2).

The frontal disc of the burner head can easily be removed for cleaning or capacity variation purposes. The burner head delivers 130 kW with no back pressure and accordingly less as the back pressure is increased. The combustion noise level is very low, which is highly desirable but not always achieved with domestic type natural gas burners.

The calculated values of CO_2 and excess O_2 with respect to excess air values and the values measured during test runs overlap exactly. This indicates that the assumed gas analysis is correct (Figure 3).

THE VALVE TRAIN

The valve train consists of one spherical valve to isolate the system from the gas mains whenever necessary. A gas filter and a pressure reducer to reduce the gas pressure to 20 milli bar follows the spherical valve. Two gas pressure sensors, one on each side of a solenoid valve to stop the gas flow if the pressure is below 15 mbar or above 25 mbar. The safety system has one more pressure sensor for the combustion air pressure, which stops the system if the pressure is below 3 mbar (Figure 4).

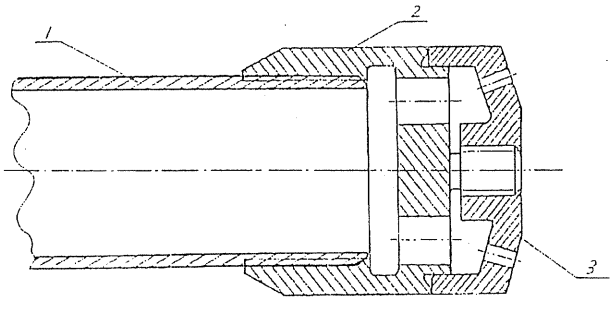

Figure 2. Burner head assembly.

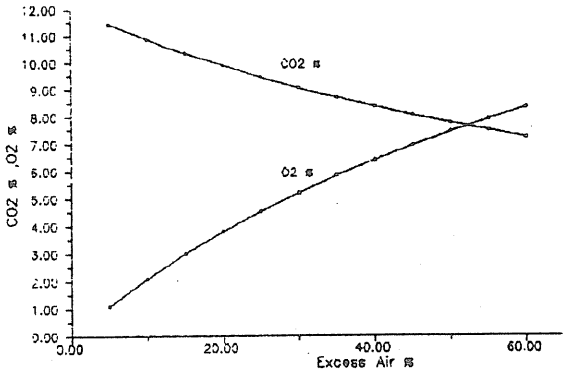

Figure 3. %CO_2 and % excess O_2 in relation to excess air

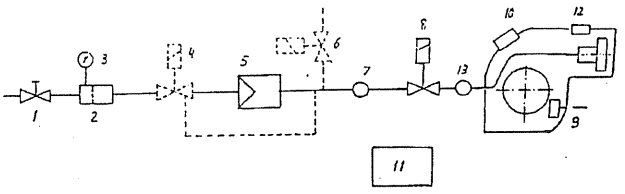

Figure 4. Configuration of control system.

1) Spherical Valve, 2) Filter, 3) Manometer, 4) Optional safety valve pressures above 0.1 bar, 5) Pressure reducer, 6) Automatic scavening for pressures above 0.1 bar, 7) Low gas pressure sensor, 8) Solenoid valve, 9) Combustion air pressure sensor, 10) Ionization flame sensor, 11) Burner control panel, 12) Spark indicator.

THE GOVERNOR

The electricity supply panel could be used with some minor changes in its original wiring and placing a new governor. The governor for the fuel-oil firing system had to be replaced with one for natural gas system. It is possible to adopt the system to German, French or English standarts by just placing the corresponding governor unit into a standard holder. This had to be so, because all three systems and the corresponding standarts are used in Turkey.

THE IGNITION SYSTEM

The ignition system of the original burner was used as it is, with no modifications. Only one ionization electrode as flame sensor and a spark indicator was added. The light sensing flame indicator of the original burner was Left in its place for the case of a reconversion.

CONCLUSION

It was possible to convert a fuel-oil burner into a natural gas burner by some relatively small changes and additions while keeping the possibility of a reconversion into a fuel-oil burner.