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ECONOMIC ANALYSIS OF REQUIRED HEAT ENERGY FOR A RESIDENCE BY USING CONDENSING AND CONVENTIONAL COMBI BOILER

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Abstract

In this study, a comparison and economic analysis of energy required for heating and hot water by condensing and conventional combi for a family was performed. After determining the energy for the family the cost of consumption energy calculated which was supplied by each two types of combi. It was determined that using of condensing combi will provide the average 15,6% energy savings to family. Furthermore, the average 40% impairment of the exhaust gas temperature of condensing combi than conventional combi causes the reduction of emissions rate and decrease the global warming. Reduction of emissions is extremely important in terms of air pollution. Compared to a conventional combi the initial investment of a condensing combi is high, but due to usage of latent heat of water vapor in the exhaust gas the payback period is short, and therefore the cost difference could be ignored. This study emphasizes that, usage of the condensing combies which are compulsory in European Union countries, will contribute the family budgets and national economy.

Keywords: Condensing combi, Conventional combi, Energy saving

BİR KONUTUN ISI ENERJİSİ İHTİYACININ YOĞUŞMALI VE KONVANSİYONEL KOMBİ KULLANILARAK KARŞILANMASININ EKONOMİK ANALİZİ

Özet

Bu çalışmada, 4 kişilik bir ailenin yoğuşmalı ve konvansiyonel kombi kullanarak ısı enerjisi ve sıcak su ihtiyacının bir karşılaştırılması ve ekonomik analizi yapıldı. Değerlendirmede ailenin ısınma ve sıcak su ihtiyacı için ısı enerjisi belirlenerek bu enerjinin her iki tip kombi ile karşılandığında ortaya çıkan enerji maliyeti hesaplandı. Yoğuşmalı kombi kullanımının aileye ortalama %15,6 enerji tasarrufu sağlayacağı belirlendi. Ayrıca egzoz gazı sıcaklığının konvansiyonel kombilere göre ortalama %40 oranında düşük olması, küresel ısınmanın azalmasına ve emisyon değerlerinin düşmesine neden olmaktadır. Yoğuşmalı bir kombinin ilk yatırım maliyetinin konvansiyonel bir kombiye göre yüksek olmasına karşın, egzoz gazındaki su buharının gizli ısısından yararlanılması nedeniyle, geri ödeme periyodunun kısa olması ilk yatırım maliyetindeki farkın göz ardı edilebileceğini gösterdi. Bireysel anlamda aile bütçesine ve ulusal bazda ülke ekonomisine katkı sağlayacağı için, Avrupa Birliği ülkelerinde kullanımı zorunlu olan yoğuşmalı kombilerin daha avantajlı olduğu, bu çalışmada gösterildi.

Anahtar Kelimeler: Yoğuşmalı kombi, Konvansiyonel kombi, Enerji tasarrufu

1 Introduction

Fossil energy use in line with the increasing environmental pollution; the greenhouse effect caused by the exhaust gases in the atmosphere leads to global warming and breaking the ecological balances in the nature. The world population means 100% increase in global energy use has increased 4-fold after 1945; consequently the world's primary energy needs continue to increase, as shown in Figure 1 [1]. This increase in energy use, led to an increase of harmful emissions and the greenhouse effect and CO2 content in the atmosphere in 1958, 315 ppm/m3 in 2004, while 379 ppm/m3 reached. This is two times more effective than other CO2 emissions increase global warming by the greenhouse effect is produced in the power generation sector. The developed countries are responsible for 76% of CO2 emissions occur in 1850-2002 years [2]. In Figure 2 the increasing of CO2 emissions by years is shown [3]. Consisting origin fossil used for energy production by combustion of fuel NOx, CO and emissions such as CO2, fuel type, the combustion process participating in the air-fuel ratio and the combustion can be controlled depending on the use of efficient technology. Serious and planned investments are carrying out in the world for efficient energy usage. The one third of energy investments in efficiency are related to energy consumption in housing industry process. The investment for energy efficiency in residential and services sector is shown in Figure 3; and the investments for heating-cooling; insulation for energy-efficient equipment and lighting space is shown Figure 4 [4].

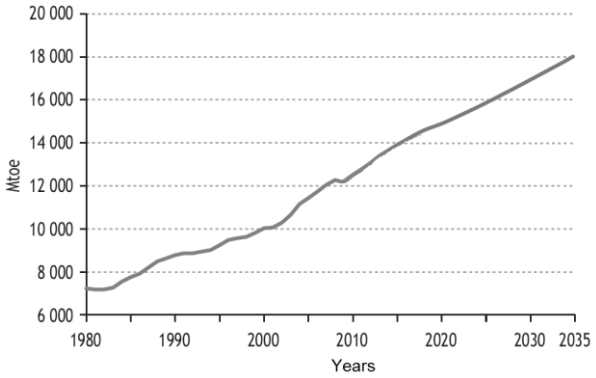

Figure 1. World primary energy consumption

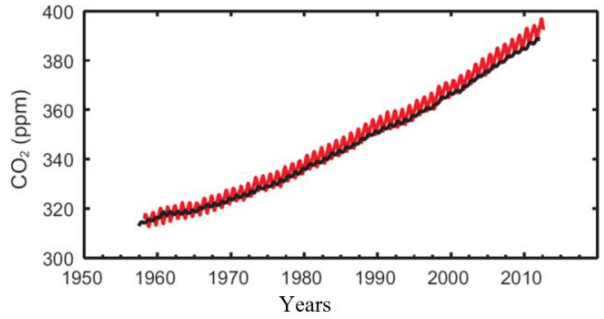

Figure 2. Increasing of CO2 by years

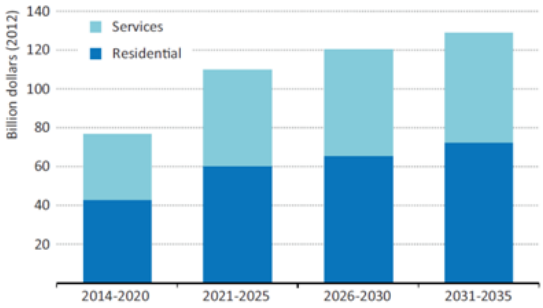

Figure 3. Average annual investment in energy efficiency in buildings in the new policies scenario

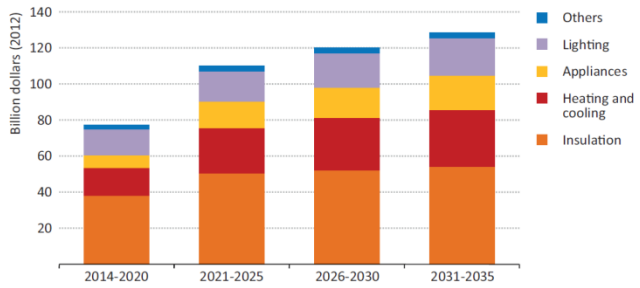

Figure 4. Average annual investment in energy efficiency in buildings by end-use in the new policies scenario

The direction of a tendency to enter the growing demand for energy costs purifiers; efficient, it has led to a compact and environmentally sensitive device. This requirement, fuel economy and low exhaust gas emissions of large increases in the amount boilers and boiler used in Turkey with condensation technology that satisfies the demand for workers combi boiler to the emergence of the system and is why it is preferred as shown in Table 1 were observed [5]. Given combi condensing boilers used in Turkey constitutes only 10% of the total boiler.

Table 1. The quantity of combies and boilers which used in Turkey between 2005-2010 [5]

Years	2005	2006	2007	2008	2009	2010
Combi	549000	684120	595510	644000	665385	754996
Boiler	6058	5712	7486	7079	5543	14130

1.1 Condensing Boiler Technology

Boilers are devices that meet the needs of individual residential heating and hot water. According to the technical details; vented boilers, hermetic boilers are classified as semi-hermetic boilers and condensing boilers. Combi boilers usage earned popularity in Turkey in a short time after 1989 because of advantages such as environmentally; lower emission; independently usage in each apartment and ability to meet the hot water and heating needs with a single device.

Condensation energy technology objectives through the utilization of heat from flue secret emerged thrown out by preventing condensation forming is to reduce fuel consumption and harmful emissions. While in conventional boiler flue gas temperature of 135-150 °C condensing boilers in waste gas temperature is lowered to 55 °C [6]. 80-95°C difference between the waste gas temperatures is reflected in the difference in yield.

Natural gas (CH4) and hydrogen molecules in the compound is burned in oxygen molecules supplied to the combustion air combine with water (H2O) are the molecules. Depending on the combustion conditions comprising 1.5 to 1.7 kg amount of water is evaporated by absorbing heat from the environment and are taken out along with the flue gas. Heat taken by the water vapor in the flue gas condensation technology of condensing combustion chamber again recuperates. Because it has a corrosive effect caused by condensation water, boiler and boiler using this technology is used special materials such as stainless steel.

Natural gas condensate with the resulting yield increase is up to 111% based on lower heating value as a theoretical value for the boiler [2]. Amount of heat obtained in this technology depends on the installation return water temperature. Return water temperature no matter how the same amount of water vapor condensing and condensing water vapor is more latent heat is revealed in parallel to the amount [7].

Premix burner technology used in condensing boilers unlike burners used in conventional boilers can operate with high efficiency in a wide modulation range. The air required for combustion, providing variable speed fan with the air and fuel before coming to the front burner homogenized the mixtures prepared with the diffuser ideal combustion conditions are provided. Instant energy demand and consequently the air-fuel ratio determined by the electronic brain condensing boilers, optimal fan speed is adjusted. Burning for air pressure depending on the controlled gas valve combustion to provide the amount of fuel needed, combine optimum combustion with

controlled air-fuel ratio with the electronic system is achieved low emissions with performing high combustion efficiency. Premix burners used air-fuel prepared by the method has a quiet operation with short flame length. Condensing boiler in combustion burner used in creating large agglomerations and preventing surface temperature harmful emissions in the waste gas formed at high temperatures. According to the employees need instant heat in a wide modulation range of yield losses to occur in this type of burner stand-up problems and high emissions have been avoided.

Conventional boilers required for combustion gas flow in fixed speed fans are used to vary the airflow is reduced efficiency due to the high excess air coefficient composed remained constant. In the absence of the boiler efficiency condensing technology is around 85-90 %. Constant speed fans used in conventional boilers is caused by the high temperature of the exhaust gas. The boiler combustion chamber to fixed speed fan to blow the same amount of air at low temperatures, more oxygen needed for combustion is thrown out with the heat drawn from the environment. If less oxygen is required to burn the combustion lacking. Increase the amount of CO is formed by the incomplete combustion of waste gases, air pollution and leads to yield losses.

2 Material and Method

31% of the energy for heating the portion produced in Turkey and 12-15% of this energy is spent to produce hot water [8]. Large parts of the energy used in homes are generally obtained from the boiler. Combi boilers and compared to the amount produced and sold in Turkey, the rate of increase in the rate of increase in the use of combined sales gains appear to be more than [5].

In this study, clear area 100 m2 with a mezzanine floor apartment of heat loss calculations for the Kars province has been calculated by monthly average outdoor temperature of Kars. The apartment is located in the northern and western side, hall, living room, bedroom, children's room, kitchen and bathroom for heat loss calculation was considered. Polyurethane foam insulation material extruded (XPS) and 5 cm on the outside walls with external, independent interdepartmental and inter-floor use is made of 3 cm acceptance. Heat losses for parts of building in winter months are calculated [9] and it is given in Table 2.

$$Q = q_i + q_s \quad (1)$$

$$q_i = q_o(1 + \%Z_D + \%Z_H) \quad (2)$$

$$q_o = kA\Delta T \quad (3)$$

$$q_s = \Sigma(al)RH\Delta TZ_e \quad (4)$$

Table 2. The heat looses of rooms

Rooms	Calculated heat lose (W)					
	November	December	January	February	March	April
Salon	759	958	1165	1269	1223	1035
Living room	355	433	514	555	537	463
Children room	1007	1061	1117	1145	1132	1082
Bedroom	429	559	694	762	732	610
Kitchen	407	559	718	797	762	619
Bath	737	737	737	737	737	737
Total	2580	2915	3266	3441	3363	3047

The average daily hot water needs for a family of four 220 liter/day considering adoption and Kars provinces spouse of mains water temperature by months. Equation (5) and (5a) for preparing hot water for heat energy required for 12 months.

$$Q = mc_p\Delta T \quad (5)$$

$$Q = mc_p(T_o + T_i) \quad (5a)$$

The amount of energy required for heating and hot water preparation by months are given in Table 3. The average monthly temperature of Kars according to the basis month to cover the heat loss calculation and the total energy requirements of the circle calculated hot water energy needs of catalog value used in conventional and condensing boilers fuel consumption and comparison in terms of initial investment costs are shown in Table 4. Costs were calculated on the basis of the current boiler and natural gas prices.

Table 3. Energy consumption of residence per months

Months	Temperature of water (°C)	Heating load (W/month)	Hot water load (W/month)
January	3	3.679.060,08	513.379,08
February	1,4	3.537.703,57	435.555,32
March	1,2	3.811.106,28	467.109,96
April	3,6	3.272.860,77	434.003,27
May	7,5	0	451.743,36
June	10,8	0	431.079,39
July	13,2	0	392.892,30
August	14,9	0	357.510,43
September	14,6	0	351.927,88
October	12,2	0	13.384,15
November	9	2.659.484,87	392.542,92
December	6,1	3.203.693,76	428.082,40

Table 4. The total consumption and cost of Natural gas for heating and hot water of residence

Combi type	Consumption of N.gas for heating (m^3/year)	Total N.gas consumption (m^3/year)	Heating cost (TL/year)	Total cost (TL/year)
Conventional combi	2.325,59	2.864,11	2.372,11	2.921,40
Condensing combi	1.962,49	2.416,94	2.001,74	2.465,27

3 Conclusion and Evaluation

The pollution created by the waste gas for energy production, considering problems such as global warming and acid rain, fossil fuels are limiting the production of energy should be used efficiently. And to reduce the emission of greenhouse gases, increasing the use of alternative energy sources, reforestation and energy efficiency in the work needs to be done effectively. In this context planned by the Kyoto Protocol; taking the amount of greenhouse gases to 5%, more fuel-efficient and much more taxing issue of carbon producing companies and organizations are thought to be important ingredients. In this study, compared to an average fuel consumption of the underlying apartment to meet the total energy needs of condensing the same power with an average fuel consumption of conventional boilers of the same power selected boiler at 15.6% compared to conventional combi condensing boiler has emerged that less fuel consumption. This difference is reflected in the 15.6% annual family costs 456 TL. The difference between the fuel consumption compared with the difference between the current price of condensing and conventional boilers, 1.5 years working to close the price gap is the efficient where the condensing boiler. When the estimated useful life of 15 years is considered boiler condensing boilers 13.5 years by providing more efficient working families an average of 15.6% total 6156 TL savings will be increased to 3.6 times its price.

Combi boilers were sold in Turkey in 2010 is 754,996.0 units [5], this amounts to 10% of the condensing boiler is that with the adoption sold in 2010 is 679,496.0 Total amount of conventional boilers. The amount of the boiler equipped with older technology has completed its economic life in Turkey is thought to have about 3.500.000,00 units [2]. Here resulting from condensing boiler used in Turkey is emerging as economic losses annually 1,596,000,000.00 TL. In a sense, the cost of energy Turkey is annually leaving in the air is 1,596,000,000.00 TL Promoting condensing boilers in recovered energy and fuel saving is taken into the economic income account obtained consumers due to their positive contribution to the national economy and the environment informing the use of these systems should be integrated into national policy. Especially natural gas fired boiler and use of condensing technology in boilers should be mandatory, as in many EU member states. According to data provided by BOTAŞ in Turkey use of natural gas will be 59.5% in 2020. Therefore, the use of natural gas in energy production in Turkey so intense promotion of condensing technology will contribute to the national economy in great extent.

Symbols

A	Area of component [m^2]
a	Inward leakage flow [m^3/m.h]
c_p	Specific heat capacity of water [J/kg ^oC]
H	Values for different situation [Wh/m^3 ^oC]
k	Heat transfer coefficient [W/m^2 ^oC]
l	Lenght of leakage region [m]
m	Amount of water [kg/day]
Q	Required energy for domestic hot water [W]
Q	Overall heat loss of room [W]
q_i	Incremental heat loss [W]
q_s	Infiltration heat loss [W]
q_o	Non-incremental heat loss [W]
R	Special feature for room [0,9]
T_o	Water outlet temperature [^oC]
T_i	Water inlet temperature [^oC]
Z_D	Unified incremental coefficient [%]
Z_e	Corner incremental coefficient [1]
Z_H	Directional incremental coefficient [%]
ΔT	Indoor and outdoor temperature difference [^oC]

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