Development of Solid Waste Management System for Adana Metropolitan Municipality

Kadir Aydin and Çağrı Ün

1 Introduction

Several categories of waste are discussed in terms of their arisings, treatment, and disposal options. The wastes described in detail are municipal solid waste, hazardous including clinical waste, household hazardous waste, and sewage sludge. Other wastes described are agricultural waste, industrial, construction, and demolition wastes, mines and quarry wastes, power station ash, scrap tires, and end of life vehicles (Williams 2005).

Municipal solid waste is a term usually applied to a heterogeneous collection of wastes produced in urban areas, the nature of which varies from region to region. The characteristics and quantity of the solid waste generated in a region are not only a function of the living standard and lifestyle of the region's inhabitants but also of the abundance and types of the region's natural resources. Urban wastes can be subdivided into two major components; organic and inorganic. In general, the organic components of urban solid waste can be classified into three broad categories: putrescible, fermentable, and nonfermentable. Putrescible wastes tend to decompose rapidly and, unless carefully controlled, decompose with the production of objectionable odors and visual unpleasantness. Fermentable wastes tend to decompose rapidly, but without the unpleasant accompaniments of putrefaction. Nonfermentable wastes tend to resist decomposition and therefore break down very slowly. A major source of putrescible waste is food preparation and consumption.

K. Aydin (✉)
Department of Mechanical Engineering, Cukurova University, Adana, Turkey
e-mail: kdraydin@cu.edu.tr

Ç. Ün
Department of Special Waste Management, Adana Metropolitan Municipality, Adana, Turkey

F. Aloui, I. Dincer (eds.), *Exergy for A Better Environment and Improved Sustainability 2*, Green Energy and Technology,
https://doi.org/10.1007/978-3-319-62575-1_8

As such, its nature varies with lifestyle, standard of living, and seasonality of foods. Fermentable wastes are typified by crop and market debris.

Wastes generated in countries located in humid, tropical, and semitropical areas usually are characterized by a high concentration of plant debris, whereas those generated in areas subject to seasonal changes in temperature or those in which coal or wood is used for cooking and heating may contain an abundance of ash. The concentration of ash may be substantially higher during winter. Regardless of climatic differences, the wastes usually are more or less contaminated with night soil. These differences prevail even in wastes generated in large metropolitan areas of a developing country.

The primary difference between wastes generated in developing nations and those generated in industrialized countries is the higher organic content characteristic of the former. The extent of the difference is indicated by the data in Table 1, in which is presented information relative to the quantity and composition of municipal solid wastes generated in several countries (UNEP 2005).

In the municipal solid waste stream, waste is broadly classified into organic and inorganic. Waste composition is categorized as organic, paper, plastic, glass, metals, and "others." These categories can be further refined; however, these six categories are usually sufficient for general solid waste planning purposes. Table 2 describes the different types of waste and their sources.

An important component that needs to be considered is "construction and demolition waste" (C&D), such as building rubble, concrete, and masonry. In some cities this can represent as much as 40% of the total waste stream.

Figure 1 shows the MSW composition for the entire world in 2009. Organic waste comprises the majority of MSW, followed by paper, metal, other wastes, plastic, and glass. These are only approximate values, given that the data sets are from various years (Hoornweg and Bhada-Tata 2012).

Nomenclature

Subscripts	
MSW	Municipal solid waste
EU	European Union
MOEF	Ministry of Environment and Forestry
MEDWP	Medical waste plastic fuel

2 Waste Generation and Management in Turkey

Waste generation and management have been recognized as a priority for Turkey and policies are being developed to overcome existing obstacles. Furthermore, MSW management has been a pressure point for Turkey while being a candidate country for EU accession.

Table 1 Comparison of solid waste characterization worldwide (% wet wt)

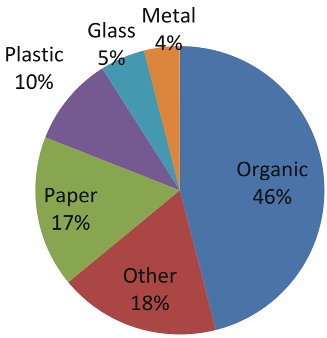
Location	Putrescibles	Paper	Metals	Glass	Plastics, rubber, leather	Textiles	Ceramics, dust, stones	Wt (g)/cap/day
Bangalore, India	75.2	1.5	0.1	0.2	0.9	3.1	19.0	400
Manila, Philippines	45.5	14.5	4.9	2.7	8.6	1.3	27.5	400
Asunción, Paraguay	60.8	12.2	2.3	4.6	4.4	2.5	13.2	460
Seoul, Korea	22.3	16.2	4.1	10.6	9.6	3.8	33.4[a]	2000[a]
Vienna, Austria	23.3	33.6	3.7	10.4	7.0	3.1	18.9[b]	1180
Mexico City, Mexico	59.8[c]	11.9	1.1	3.3	3.5	0.4	20.0	680
Paris, France	16.3	40.9	3.2	9.4	8.4	4.4	17.4	1430
Australia	23.6	39.1	6.6	10.2	9.9	–	9.0	1870
Sunnyvale, California, USA	39.4[d]	40.8	3.5	4.4	9.6	1.0	1.3	2000

[a]Includes briquette ash (average)
[b]Includes “all others”
[c]Includes small amounts of wood, hay, and straw
[d]Includes garden waste

Table 2 Types of waste and their sources

Type	Sources
Organic	Food scraps, yard (leaves, grass, brush) waste, wood, process residues
Paper	Paper scraps, cardboard, newspapers, magazines, bags, boxes, wrapping paper, telephone books, shredded paper, and paper beverage cups. Strictly speaking paper is organic, but unless it is contaminated by food residue, paper is not classified as organic
Plastic	Bottles, packaging, containers, bags, lids, cups
Glass	Bottles, broken glassware, light bulbs, colored glass
Metal	Cans, foil, tins, nonhazardous aerosol cans, appliances (white goods), railings, bicycles
Other	Textiles, leather, rubber, multi-laminates, e-waste, appliances, ash, other inert materials

Fig. 1 Global solid waste composition (2009)



Environment Law No 2872 was rectified on 9 August 1983 and was amended in 1988 and 2001 and modified by Law No: 5491 on 26.04.2006. This Framework law aimed protection and improvement of environment in line with the sustainable protection and development principles; it puts forward the rules and principles for environmental protection, defines the responsible and authorized institutions and organizations, determines the processes for the implementation, and establishes punishments for improper acts and liabilities of the concerned within the framework of the principle "polluter pays." It also emphasized the efficient use of natural resources. Environmental Protection Institutes were established later by the year 1989 to ensure the environment law is implemented successfully. The law also paved the way for the establishment of provincial environment boards to oversee environmental protection in their respective regions.

In its 3rd section, the law prohibits disposal of all types of waste and scraps into recipient environment unless necessary precautions have been taken, determined by specific regulations. Environment-friendly technologies must be used during all kinds of activities so as to efficiently use natural resources and energy, which also means reduction of waste production at source and recycling of waste. The law also determined the status and procedure for protected areas and defines penalty mechanism for those who do not comply with the standards.

Regulation on Solid Waste Control was approved on 14 March 1991 (No 20814) and was later amended in 1991, 1992, 1994, 1998, 1999, 2000, 2002, and finally on 5 April 2005 (No 25777). The general framework of waste management system requires the reduction of waste generation as far as possible, separation of recoverable waste at source and recycling the valuable wastes and disposal of nonrecyclable wastes by means of environment-friendly methods. The purpose of this regulation is to forbid all waste management activities posing a threat to the environment. It also aimed at the protection of natural flora and fauna.

This regulation provides general information about different types of wastes like packaging waste, construction and demolition waste, waste sorting, waste transport and disposal, as well as information about landfills and incineration. However, each of these components is governed by a specific regulation for itself.

Solid waste collection and management is one of the most significant local public services. The manner in which such services are delivered is of utmost importance for public health as well as for the protection of the environment. As per the below laws and regulations, liabilities for the collection, transportation, recycling, and disposal of solid wastes are entrusted to the municipalities and metropolitan municipalities.

The By-Law on Solid Waste Control is the first important step toward successful waste management in Turkey. Although it is shown to have some shortcomings in its implementation, the MSW management system has been improved by new studies and new regulations. The main reasons for the shortcomings can be identified as:

- Waste management systems development was not a priority policy area.
- Duties and powers are distributed among many institutions and organizations, with inadequate coordination and cooperation among them.
- The fees and taxes collected in return for services were inadequate.
- The infrastructure (facilities and the existing technical capacity) was limited and the majority of facilities were in need of modernization.

According to the Metropolitan Municipality Law (10.7.2004, 5216) and the Municipality Law (3.7.2005, 5393), sole responsibility for the management of municipal waste falls on the municipalities. They are responsible for providing all services regarding collection, transportation, separation, recycling, disposal, and storage of solid wastes, or to appoint others to provide these services. Nevertheless, while fulfilling their duties in collecting and transporting the solid waste to a great extent, they do not show the required level of activity and attention in solid municipal waste management. The great majority of solid waste in the country is still not being disposed in accordance with the legislation. This situation has been improving by newly adopted management perspectives.

It has been reported that 54% of household waste is disposed in sanitary landfill sites, while the remaining 44% is dumped into dumpsites, according to the Turkish Statistical Institute. 2% was reported as either undergoing biological treatment or disposed of by other methods. The number of sanitary landfills is increasing rapidly in Turkey, as in 2003 there were 15 sanitary landfills, whereas in the 3rd quarter of

2012 this number has increased to 68. There are references in the literature to an informal recycling sector which could be responsible for up to 30% of MSW material recycling. But there is no information on the current situation concerning this informal recycling practice. Regarding the situation around packaging waste, an important part of MSW, the Turkish Ministry of Environment and Urbanization has provided the following information.

The first particular regulation on packaging waste control came into force in 2004 with the "By-Law on Control of Packaging Waste" and was revised in August 2011. The aim of the by-law is to minimize the generation of packaging waste and to also increase the rate of recycled packaging waste which cannot be avoided within the method of production. The regulation also includes principles and standards for packaging waste to be collected separately at its source, then sorted and transported within a certain system. Institutions and suppliers who are not members of authorized organizations are obliged to recover packaging waste. Recycling targets are given to authorized institutions and suppliers with this by-law. The number of economic operators registered to the system is increasing rapidly in Turkey, from 350 in 2003 to 15,192 in 2012.

The Turkish Ministry of Environment and Urbanization gives licenses to collection, separation, and recycling facilities. Whereas there were only 28 licensed facilities in 2003, this number increased to 562 in 2012. Development plans are the main tools for the coordination of public policy in Turkey and they form the basis of policy documents on solid waste. There have been a number of National Waste Management Plans covering the period 2009–2013. The main aim of the Plan is to determine national policies and the decision-making structure for the preparation of detailed waste management plans for separate waste streams. The latest plan was made with the aim of fulfilling criteria according to the EU harmonization process.

Finally, in 2008, the "By-law on General Principles of Waste Management" (05.07.2008, 2697) set the framework for waste management in Turkey from waste generation to disposal so that the procedures are followed in an environmentally sound way (Bakas and Milios 2013).

The Turkish Ministry of Environment and Urbanization has carried out various regional fieldworks in order to determine the domestic waste composition of households in Turkey in addition to solid waste surveys sent to cities that are representative of Turkey. The outcome of these studies, municipal waste composition in Turkey, is shown in Fig. 2 (Anonymous 2014).

3 Waste Management of Adana Municipalities

Adana Province is located at the Mediterranean Sea Region among the 35–38° northern latitude and 34–36° eastern longitude. The surface area is 14,030 km^2 and the altitude is approximately 23 m. The province has a 160 km coastline on the Mediterranean Sea. It comprises 15 districts, 55 municipalities, and 517 villages. The forest land in the province forms approximately 39% of the total area. Total

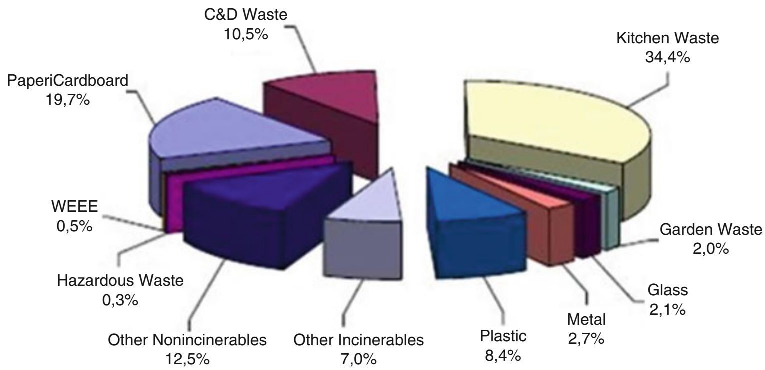


Fig. 2 Composition of domestic wastes in Turkey

meadow land in the region is equal to 3% of the total area. Various types of agricultural practices are performed in the region, total agricultural land is equal to 38% of the total area, and 19% of the total area is used for other purposes.

With the construction of Seyhan Dam and improvements in agricultural techniques, there was an explosive growth in agricultural production during the 1950s. Large-scale industries were built along D-400 state road and Karataş road. Service industry, especially banking, also developed during this period.

Adana is the marketing and distribution center for Çukurova agricultural region, where cotton, wheat, corn, soy bean, barley, grapes, and citrus fruits are produced in great quantities. Farmers of Adana produce half of the corn and soy bean in Turkey. 34% of Turkey's peanuts and 29% of Turkey's oranges are harvested in Adana. Most of the farming and agricultural-based companies of the region have their offices in Adana.

Adana has been the agricultural and economical center of attention. As one of the most fertile plains in Turkey, Çukurova produces sunflower, olive, corn, citrus (orange, mandarin, and lemon), kiwi, sugarcane, rice, soy bean, cotton, grape, peanut, almond, melon, loquat, etc. The economy of the city is generally based on agriculture and stockbreeding. Since land and climate structures are convenient, all kinds of agricultural produce are grown. Irrigated farming is done in a 49,330 ha section of total agricultural land. Olive, grain, tomatoes, pepper, tobacco, corn, sugar beet, cotton, melon, watermelon, and peach are the main produce that are grown.

According to the new Metropolitan Municipalities Law No. 6360, after the March 2014 elections, the service area of Adana Metropolitan Municipality has been expanded to cover the entire geographical area of Adana. Adana Metropolitan Municipality has to collect, transport, and dispose of solid wastes produced by its 2,149,260 people. Adana Metropolitan Municipality collects on an average 554,139.06 tons per year of solid wastes and 2,831.79 tons per year of medical wastes, excluding Yedigöze Union. The seven municipalities and their villages of Yedigöze Union also collect 94,285 tons/year of solid wastes. About 42.5% of this waste was collected from Center of Ceyhan municipality, 40.5% from Center of Kozan municipality, 7.5% from the Center of İmamoğlu municipality, 4.5% from Center of Yumurtalık municipality, 1.9% from Center of Feke municipality, and 1.6% from Center of Saimbeyli and Aladağ municipalities (Turkstat 2013). All solid wastes collected from Adana Metropolitan Municipality, except Yedigöze Union, were transported to Adana Metropolitan Municipality Landfill Site for recycling and disposal. Solid wastes collected from Yedigöze Union are disposed of in uncontrolled dumping areas, except Ceyhan that transfers its waste to Adana Landfill site using the transfer station in Ceyhan, situated in each district. All medical wastes collected from Adana Metropolitan Municipality including Yedigöze Union are transferred to the Adana Metropolitan Medical Waste Sterilization Unit, which is located in Adana Metropolitan Municipality landfill. After sterilization, all medical waste is disposed of at the sanitary landfill of Adana as nonhazardous waste (Draft Master Plan for Yedigöze Union 2014) (Fig. 3) (Tables 3, 4, 5, and 6).

The average compositions of solid wastes in Adana Metropolitan Municipality are 60–64.5% organic wastes, 8.07% plastic materials, 2.42% papers, 0.25 metals, 1.87% glasses, and 22–25% others (tire, leather, textile wastes, ash, stone, and soil). All organic wastes are transferred to the dry plug flow anaerobic digestion with gas exploitation, followed by composting after separation process. 22,604,832 Nm^3 per year landfill gas is produced from the organic wastes and the landfill gas is converted to 2,712,580 kW of electricity per year by gas engines. 249,318 tons per year of composts is also produced from the organic wastes. 68,928,799 kg medical wastes were collected from 1449 health institutions in Turkey in 2012. 46% of medical wastes were sterilized and disposed of at a controlled landfill site, 28% of medical wastes were not sterilized and were disposed of at a controlled landfill site, 16% of medical wastes were sterilized and disposed of at municipal dumping site, 1% of medical wastes were not sterilized and were disposed of at municipal dumping site, and 8% of medical wastes were disposed of in an incinerator. 2,959,837 kg medical wastes were collected from 26 health institutions in Adana in 2012 and nearly all medical wastes in Adana were sterilized and disposed of at Adana Metropolitan Municipality dumping site.

The Yedigöze Union currently (2014) has a population of 386,848 inhabitants including seven districts: Ceyhan, Kozan, İmamoğlu, Yumurtalık, Saimbeyli, Feke, and Aladağ.

The 7 municipalities and their villages in Yedigöze Union also collect 94,285 tons/year of solid wastes. About 42.5% of this waste was collected from Center of Ceyhan municipality, 40.5% from Center of Kozan municipality, 7.5% from the Center of İmamoğlu municipality, 4.5% from Center of Yumurtalık municipality, 1.9% from Center of Feke municipality and 1.6% from Center of Saimbeyli and Aladağ municipalities. All solid wastes collected from Adana Metropolitan Municipality, except Yedigöze Union, were transported to Adana Metropolitan Municipality Landfill Site for recycling and disposal. Solid wastes collected from Yedigöze Union are disposed to uncontrolled dumping areas, except Ceyhan that

Fig. 3 Location of Yedigöze Union cities in Adana

transfers its waste to Adana Landfill site using the transfer station in Ceyhan, situated in each district.

The 7 municipalities and their villages in Yedigöze generated 156,031 tons/year of waste in 2012. About 60.4% of this waste was generated in urban locations and 39.6% was generated in rural locations. About 36.4% of this waste is generated from middle income, 12.4% from high income, 39.6% from rural locations, 7.2% from low income, 2.9% from the commercial strata, and 1.5% from the tourist strata. The population of Yedigöze is affected during the summer season; therefore, waste generation is affected as well. The average per capita waste production in Yedigöze Union was 0.98 kg/inhabitant*day in 2012 (Draft Master Plan for Yedigöze Union 2014).

Table 3 Waste composition for Yedigöze Union in 2012, (tonnes)

Material category	High income	Middle income	Low income	Commercial	Rural	Tourism	Total (ton)
Organic	11,439	32,566	6523	2046	35,396	1245	89,214
Kitchen/ Cant. Waste	11,041	30,999	5208	1510	28,189	1145	78,092
Garden/ Park Waste	398	1567	1315	536	7207	100	11,123
Wood	32	247	26	10	137	6	458
Paper/ Cardboard	1689	4564	440	776	2520	272	10,261
Paper	1037	2626	301	479	1716	178	6338
Cardboard	651	1938	139	296	804	94	3922
Glass	488	1534	148	350	816	90	3426
Plastics	1929	5254	613	569	3428	257	12,051
Textiles	297	2273	391	90	2157	60	5267
Metals	63	274	23	30	127	7	525
Hazardous Waste	158	248	101	25	555	18	1105
Composites	184	410	73	33	396	23	1119
WEEE	4	18	6	7	34	0	69
Other Composites	180	392	67	26	362	23	1050
Inert Materials	170	373	1324	94	7535	26	9521
Other Categories	2502	4798	685	193	3779	307	12,264
Fine < 10 mm	462	4178	911	280	4899	89	10,820
Total	19,411	56,719	11,259	4497	61,745	2400	156,031

4 Experimental Facility

4.1 Setup

In this study, a pilot cracking reactor was designed and used for thermal cracking. The reactor consists of a heat exchanger, a PT 100 type thermocouple in order to measure the variation of temperature inside the reactor, a digital temperature indicator, a filler cap, a drain cover, and a manometer. Stainless steel number 316 L is used as the main material for the reactor manufacture. Figure 4 shows the technical drawing of the reactor.

Hospital disposals, like PP and PVC syringes, infusion sets, latex medical gloves, blood, and diffusion bags, were collected from Adana State Hospitals (Fig. 5).

Firstly, medical waste plastics were dried, triturated, and loaded into the thermal cracking reactor. The reactor was heated up to the starting temperature of reaction;

Table 4 Generation rate forecast for Yedigöze Union 2012–2045

Material category/year	2012	2015	2025	2045
Organic waste	199.1	207.1	211.0	220
Biodegradable kitchen/Cant. waste	174.3	181.8	186.7	198.4
Biodegradable garden/Park waste	24.8	25.4	24.3	21.6
Wood	1.0	1.1	1.1	1.2
Paper/cardboard	22.9	24.9	29.3	41.9
Paper	14.1	15.5	19.0	28.7
Cardboard	8.8	9.3	10.3	13.2
Glass	7.6	8.0	8.5	9.6
Plastics	26.9	29.9	38.1	62.5
Textiles	11.8	12.2	12.4	12.8
Metals	1.2	1.2	1.4	1.7
Hazardous waste	2.5	2.6	2.7	2.9
Composites	2.5	2.6	2.7	3.0
WEEE	0.2	0.2	0.2	0.3
Other composites	2.3	2.4	2.5	2.7
Inert materials	21.3	21.4	19.5	15.2
Other categories	27.4	29.9	36.0	53.3
Fine < 10 mm	24.2	23.0	17.6	10.3
Total	**348.3**	**364.1**	**380.4**	**405.6**

Table 5 Medical waste generation and management in the Yedigöze Union, 2012

District	Medical waste (tonnes)	Medical waste collection, transport and disposal
Ceyhan	146	Collected by ITC and, after sterilization, disposed of in Adana Metropolitan Municipality Sanitary Landfill
Kozan	109	
İmamoğlu	28	
Yumurtalık	7	
Saimbeyli	5	
Feke	6	
Aladağ	6	
Total	**307**	

Table 6 Existing dumpsites in Yedigöze Union

No. district ownership	No. district ownership	No. district ownership
1	Ceyhan	Transfer Station, No Dumpsite
2	Yumurtalık	Treasury
3	Kozan	Treasury
4	İmamoğlu	Treasury
5	Aladağ	Forest
6	Feke	Treasury
7	Saimbeyli	Treasury

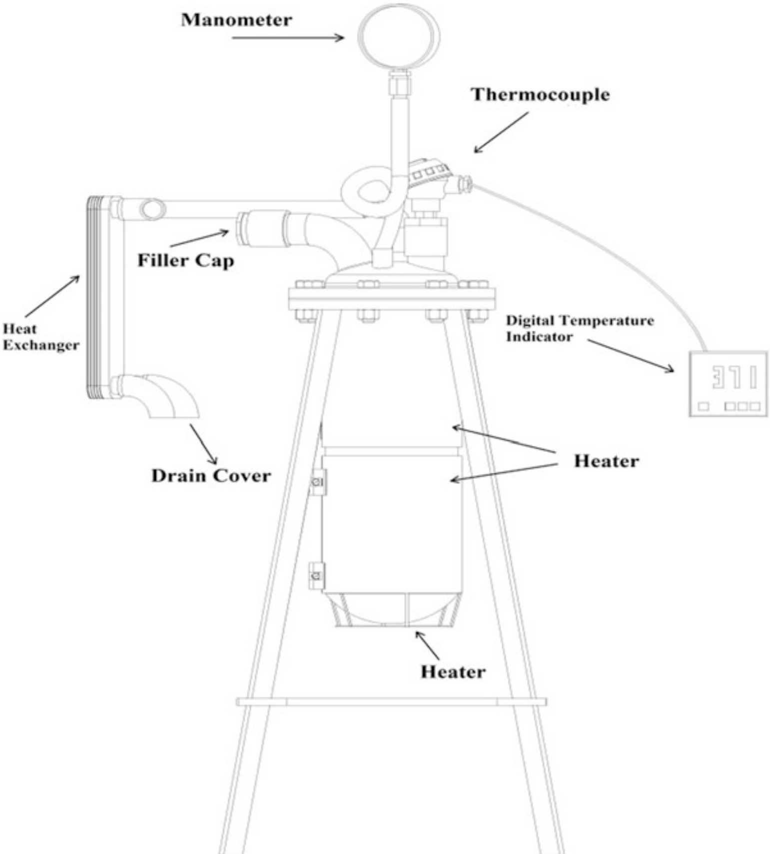


Fig. 4 Technical drawing of reactor

Fig. 5 Medical waste plastic samples

Fig. 6 Distilled medical waste plastic fuel samples

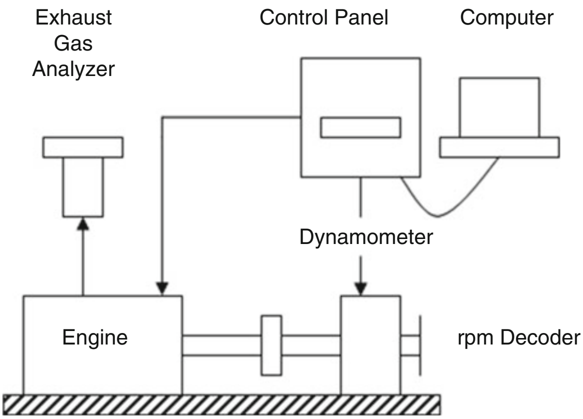


Fig. 7 Experimental setup

subsequently the reaction was started and continued between 450 °C and 475 °C. The reaction was carried out for 1.5 h. During the thermal cracking reaction, the gaseous phase formed, and then the gaseous phase was transformed to the liquid form by using plate type heat exchangers. The product was distilled into a drain cab and the final product was taken from the cab. Distilled medical waste plastic fuels are shown in Fig. 6.

In this study, three different medical waste plastic fuel (MEDWP) blends were prepared (10% Medical Waste Plastic Fuel + 90% Diesel Fuel, 20% Medical Waste Plastic Fuel + 80% Diesel Fuel, and 50% Medical Waste Plastic Fuel + 50% Diesel Fuel). The blends have been analyzed by the standards of ASTM test methods. At the engine experiments, Mitsubishi 4D34-2A type four stroke-four cylinder diesel engine, which has a 3907 cc engine volume, 89 kW maximum power at 3200 rpm and 295 Nm at 1800 rpm, was used. Torque and brake power of the engine were measured with a dynamometer. The exhaust emissions were measured by a Testo 350XL gas analyzer (Fig. 7). All experiments were repeated three times.

5 Results and Discussions

5.1 Fuel Properties

Measured fuel properties of MEDWP and its blends are shown in Table 7.

5.2 Engine Performance

Brake power and torque output values of diesel fuel + 10%, 20%, and 50% MEDWP blends are shown in Figs. 8 and 9.

Table 7 MEDWP fuel properties

Properties	Diesel fuel	MEDWP 10	MEDWP 20	MEDWP 50	MEDWP 100
Density (kg/l)	0.830	0.845	0.858	0.894	0.940
Cetane number	55.57	54.52	53.20	51.48	46.58
Pour point (°C)	−16.0	−13	−10.5	−6.0	3.0
Viscosity (cSt)	2.45	2.42	2.41	2.39	2.30
Calorific value (kcal/kg)	11,320	11,105	10,980	10,650	9850
Flash point (°C)	70.5	65.5	65.5	65.5	65.5

Only MEDWP 10 blends met the EN 590 diesel fuel standards

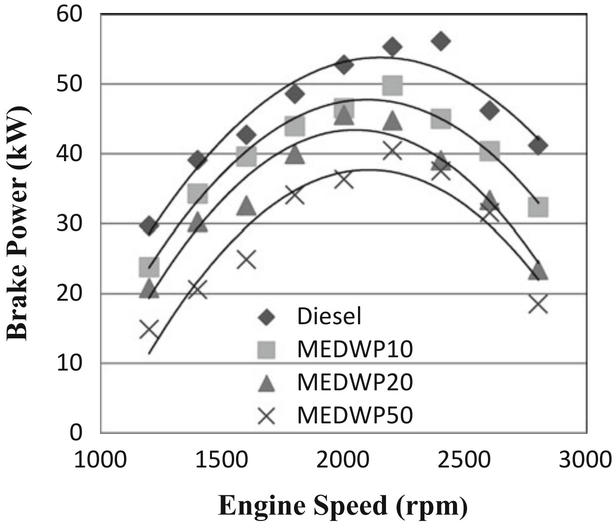


Fig. 8 Brake power outputs of diesel and MEDWP blends

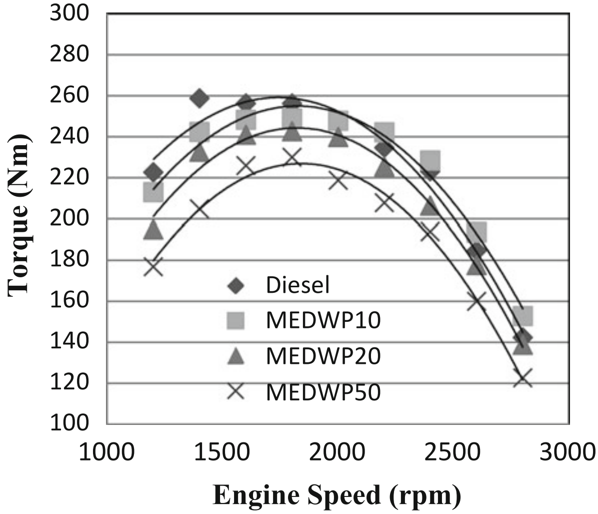


Fig. 9 Torque outputs of diesel fuel and MEDWP blends

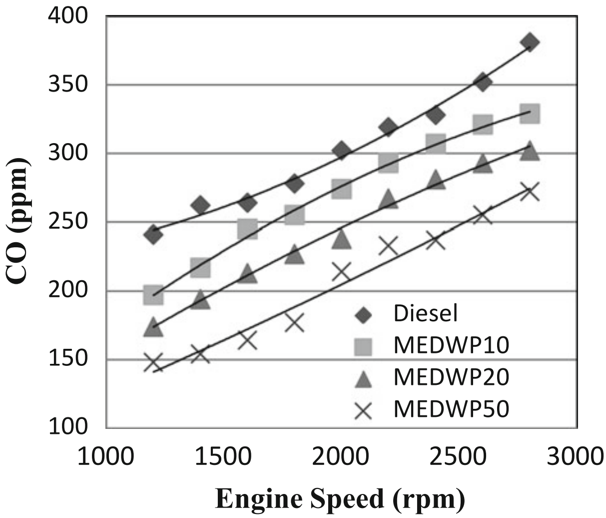


Fig. 10 CO values of diesel fuel and MEDWP blends

5.3 Exhaust Emissions

CO, CO_2, and NO_x values of diesel fuel+ 10%, 20%, and 50% MEDWP blends are shown in Figs. 10, 11, and 12.

CO values of MEDWP blends are lower than diesel fuel because of the lower viscosity of MEDWP (Fig. 10). Lower viscosity increases atomization of fuel injection during injection. CO_2 values of MEDWP blends are also lower because

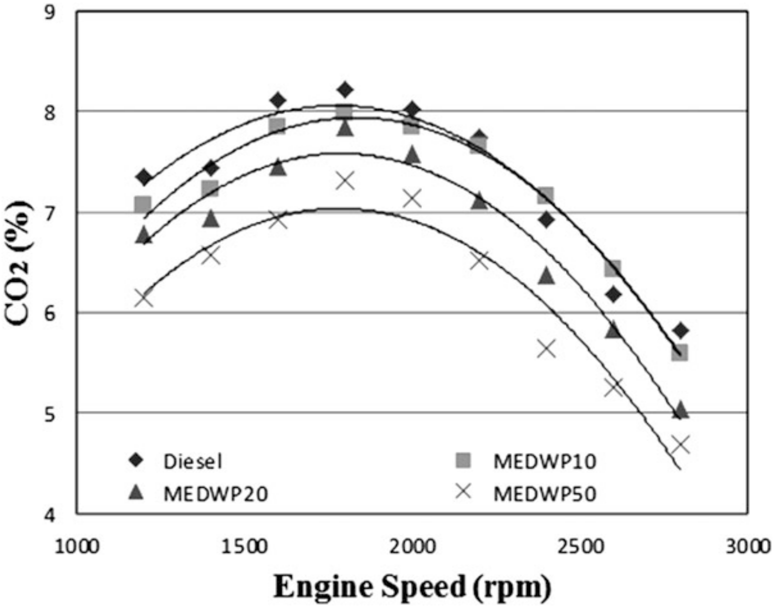
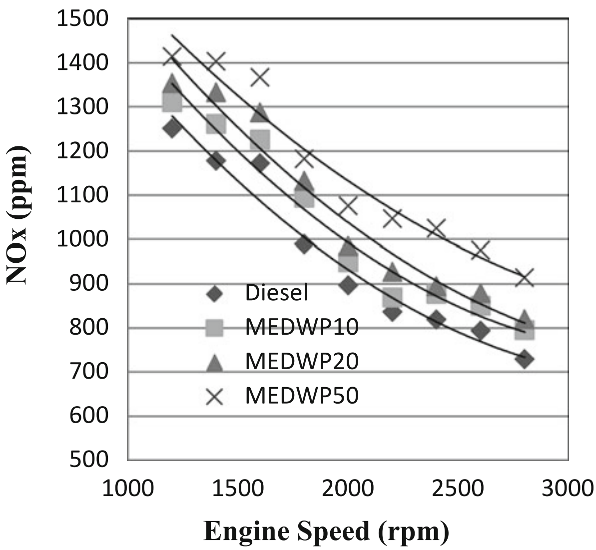


Fig. 11 CO_2 values of diesel fuel and MEDWP blends

Fig. 12 NO_x values of diesel fuel and MEDWP blends



of lower ratio of Carbon atoms in MEDWP fuels than diesel fuel (Fig. 11). NO_x values of MEDWP blends are higher than diesel fuel because better atomization creates higher combustion temperature in the engine cylinder (Fig. 12). NO_x emissions are only dependent on in-cylinder combustion temperature.

6 Conclusions

The main aim of this study is to develop a new infrastructure for integrated solid waste management for Adana Metropolitan Municipality including Yedigöze Union. New transfer stations have to be located in Yedigöze Union to transfer all collected solid wastes to Adana Metropolitan Municipality Landfill Site for recycling and disposal. All plastic materials including medical wastes collected from Adana Metropolitan Municipality including Yedigöze Union have to be transferred to the thermal and catalytic cracking unit for producing plastic fuel. All medical wastes will be sterilized and converted to plastic fuel without any Medical Waste Sterilization Unit. This solution reduces the medical waste disposal without spending any energy for sterilization. Experiments showed that medical waste plastic fuel can be blended with diesel fuel by the ratio of 10% and can be used for waste collection trucks without any modification. 10% MEDWP fuel addition to diesel fuel also reduces CO and CO_2 emissions (Aydın and Ün 2014). MEDWP fuel addition to diesel fuel results in better environmental impact. Creating an all type waste plastic (municipal and medical) collection infrastructure, producing and using waste plastic fuel are one of the innovative approaches for waste management.

References

Anonymous.: http://www.eea.europa.eu/soer/countries/tr/waste-state-and-impacts-turkey (2014). Accessed 20 Dec 2014

Aydın, K., Ün, Ç.: Production, engine performance and emission studies of medical waste plastic fuel and its blends with diesel fuel. In: Proceedings of Venice 2014, Fifth international symposium on energy from biomass and waste, San Servolo, Venice, 2014

Bakas, I., Milios, L.: Municipal waste management in Turkey. European Environment Agency (2013)

Draft Master Plan for Yedigöze Union.: Technical assistance to prepare integrated solid waste management projects-lot 1. Parsons Brinckerhoff, New York (2014)

Hoornweg D., Bhada-Tata P.: What a waste: a global review of solid waste management. World Bank, Urban Development Series Knowledge Papers, No. 15., (2012)

Turkstat.: Waste statistics of health institutions at turkey. Turkish Statistical Institute Press Releases, Issue: 16117 (2013)

UNEP.: Solid waste management, vol. I, United Nations Environmental Programme, CalRecovery Inc. (2005)

Williams, P.T.: Waste treatment and disposal, 2nd edn, p. 390. John Wiley & Sons, Ltd. (2005)