

**PRELIMINARY SURVEY REPORT
ON
ANKARA AIR POLLUTION
CONTROL PROJECT
IN
TURKEY**

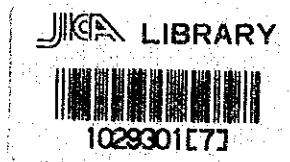
December 1983

Japan International Cooperation Agency

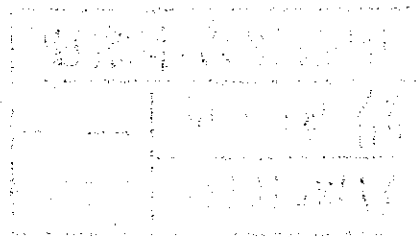
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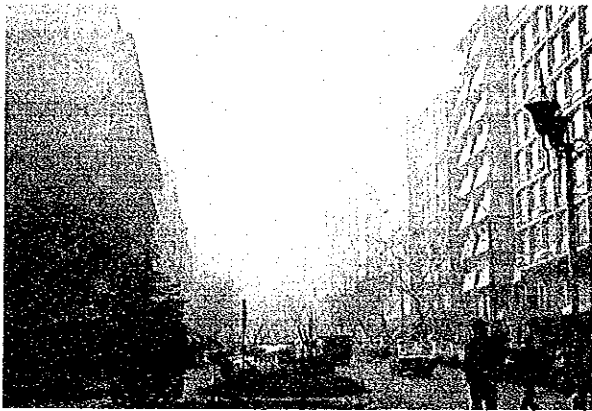
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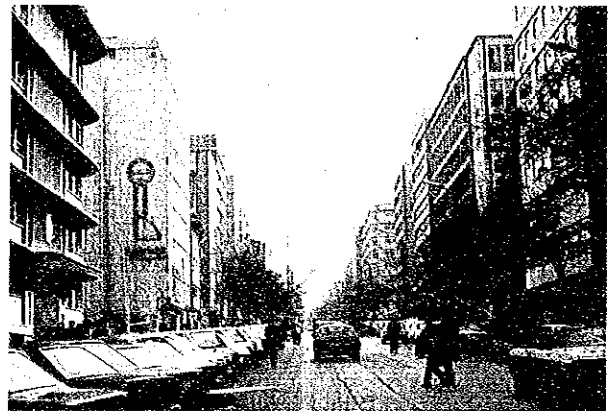
Ankara City from the official residence of Japanese ambassador



Gecekondu district



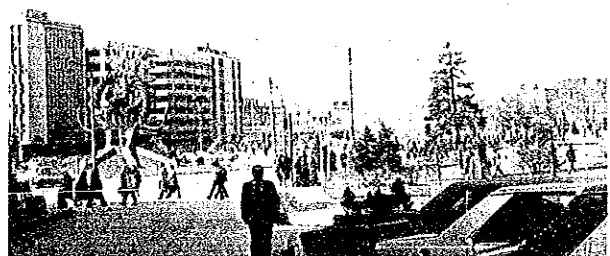
A street on front of Kent Hotel (morning)



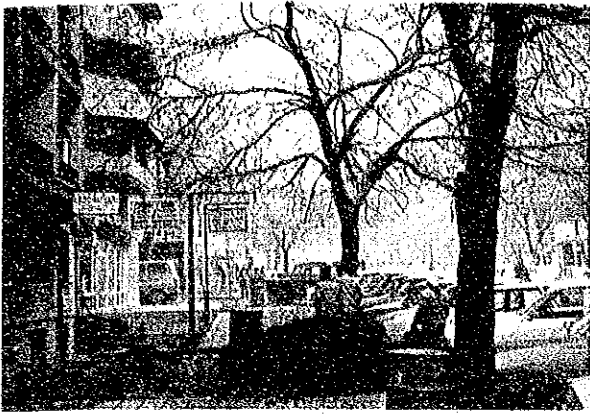
A street on front of Kent Hotel (afternoon)



A square near Kent Hotel (morning)



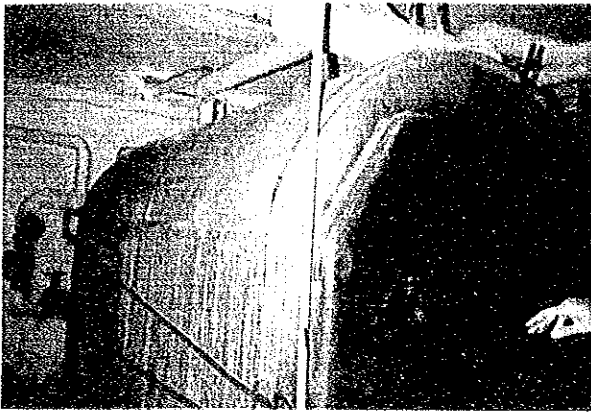
A square near Kent Hotel (afternoon)



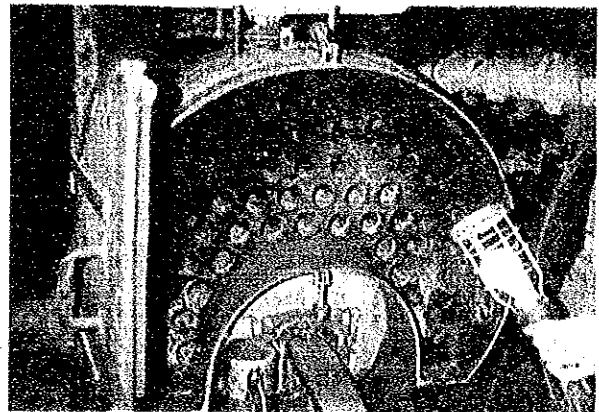
Lignite piled on the street



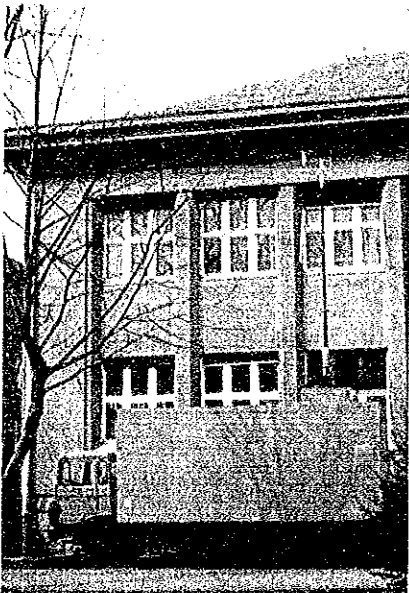
Lignite



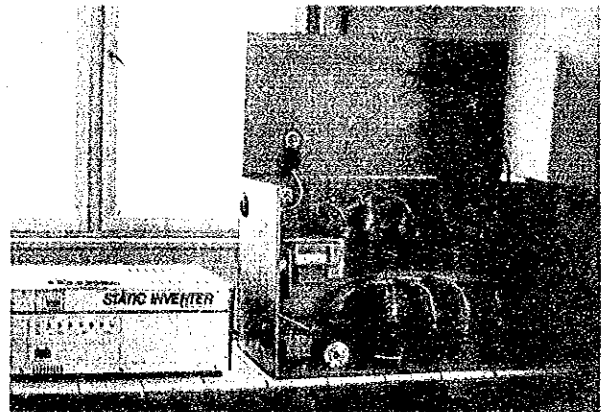
Heating boiler for apartment house
(use lignite)



Heating boiler of office of Under-
secretariat for Environment (use oil)



Survey vehicle of ambient air



SO₂ measurement equipment

PREFACE

Japanese Government decided to make an investigation for countermeasures against air pollution in Ankara, Turkey at the request of Turkish Government; and, we, Japan International Cooperation Agency (JICA), were selected to take this charge.

JICA, therefore, despatched a contact mission for the investigation headed by Mr. Masaaki Sakurai (Assistant to Director - general, Air Quality Bureau, Environment Agency) from March 8 to March 19, 1983 to Ankara to confirm the contents of the request of Turkish Government, to deliberate with the Turkish Government authorities over the basic plan for the investigation and others and to collect relevant information and data.

This report deals with the results of preliminary survey and is meant for a reference for conclusion of Scope of Work (S/W) and execution of full-fledged investigation expected to follow the contact mission.

December 1983

Ichihito NAKAZAWA
Director
Japan International Cooperation Agency

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Chapter 1 Background and Circumstances Leading to Despatching a Contact Mission

The problem of air pollution was recognized openly in Ankara, Republic of Turkey, in the latter half of 1960s.

Anatolia Plateau under the continental climate where Ankara is located can be as cold as minus 20°C or below in winter, and a large amount of coal (mostly lignite) is burnt in the residences and offices for space heating. The lignite used here is of very poor quality, and the smoke and soot from lignite burning are indicated to be the main causes of air pollution.

In addition to the poor quality of fuel for space heating, Ankara is located at the bottom of a basin, and the population is increasing in recent years by chaotic inflow of people into the city; and these factors aggravate the pollution.

The air pollution being caused by the burning of space heating fuel, it is serious in winter from November to March; and it is mitigated of itself as spring comes to the city. Especially in winter 1981/82, 24 hour average SO₂ concentration reached up to 1,935.75 µg/m³, and the government took actions such as closing primary schools, urging people to refrain from space heating, forbidding people to go out without urgent need, etc.

Turkish Government established Undersecretariat for Environment in charge of environmental problems including air pollution in 1979, received a loan of 6 million dollars from the World Bank, arranged air quality monitoring stations, and planned "Immediate Pollution Control Program" and "Long-term Pollution Control Program", among other actions, and started their efforts to correct the situation.

The immediate program includes supply of lignite of better quality, training of boilermen, improving boilers, heat insulation of buildings to save fuel, monitoring exhaust gas, etc. and is, so to say, symptomatic treatments. The long-term program includes establishing technology for making smokeless solid fuels from lignite, examining the possibility of gasification and district heating, etc. that are for establishing radical measures for the solution.

Under the circumstances, Turkish Government requested cooperation to Japanese Government who has an experience in solving the problem of air pollution.

The principal items of Turkish Government's request conveyed to us before the preliminary survey were as follows:

- (1) cooperation on improving the space heating system (improving the performance of space heating boilers for the higher efficiency of combustion)
- (2) cooperation on confirming the technical and economical feasibility of district heating.
(technical and economical comparison among gasification of lignite, town gas distribution project, and district heating program)

For JICA it's the first experience to survey is the field of air pollution control herewith. And additionally the contents of request by Turkish Government are seemed to be duplicated with the cooperation already provided by other countries or international organizations such as the World Bank. Therefore, we considered it necessary to confer with the Turkish Government authorities on the possible fields of our cooperation in view of the present status of air pollution, and the various measures taken by Turkish Government; and we despatched a contact mission from March 8 to March 19 under cooperation of Japan Environment Agency.

The contact mission was originally awaited with much expectation by Turkish Government authorities and Japanese Embassy to bring some kind of advices on concrete measures of solution. But it was confirmed by Ministry of Foreign Affairs, Environment Agency, and JICA that the despatch of the mission is just a beginning of cooperation; and this was conveyed to the Turkish Government in advance through Japanese Embassy in Ankara.

Chapter 2 Outline of Contact Mission

2-1 Assignment of Contact Mission

The purposes of the contact mission are the following.

- (1) To investigate the background of request in detail
- (2) To confirm the concrete contents of request
- (3) To investigate the present situation of cooperation by the World Bank or other organization and countries and to find the relationship between the progressing cooperation and the contents of request of this time
- (4) To investigate the regulations, legal actions, etc. concerning the air pollution control
- (5) To investigate the monitoring system
- (6) To collect the existing monitoring data
- (7) To collect fundamental data on the topography, weather, energy use, urban planning, etc.
- (8) To examine the policy for future cooperation

2-2 Organization of Contact Mission

The contact mission was organized by the following members.

Chief of mission: Masaaki Sakurai, Assistant to Director General of

Air Quality Bureau, Planning Division,
Air Quality Bureau, Environment Agency

Takashi Kurihara, Assistant Chief, International Affairs
Division, Minister's Secretariat,
Environment Agency

Tokuhisa Yoshida, Assistant Chief, Planning Division
Air Quality Bureau, Environmental Agency

Hiroyasu Tokuda, Technical Officer, Air Pollution Control
Division, Air Quality Bureau,
Environment Agency

Toshio Nakamura, Officer, Second Development Survey
Section, Social Development Cooperation
Department, Japan International
Cooperation Agency

2-3 Itinerary of Contact Mission

The itinerary of the contact mission and the names of Turkish Government authorities interviewed are shown in the following table, where group A is composed of the chief of mission, Mr. Kurihara and Mr. Nakamura, and the members of group B are Mr. Yoshida and Mr. Tokuda. The itinerary without mentioning the group is for all the member.

No.	Date	Time	Group	Itinerary	Item of Investigation
1	March 8 (Tue)			Tokyo	
2	March 9 (Wed)			Frankfurt → Istanbul → Ankara	
3	March 10 (Thu)	Morning		Visit Undersecretariat for Environment.	Confer with Mr. Refet Erim, Undersecretary and Mr. Tansu Gürpınar, Chief of Department on the itinerary.
		Afternoon		Courtesy visit to Minister Nimet Özdağ (in charge of Undersecretariat for Environment). Visit official residence of the ambassador of Japan. Visit Undersecretariat for Environment. (Participants) Ministry of Foreign Affairs Ministry of Health and Social Welfare Ministry of Industry and Technology Ministry of Energy and Natural Resources Ministry of Reconstruction and Settlement State Planning Organization Middle East Technical University Turkish Coal Board Mineral Research and Exploration Institute Municipal Electricity, Gas and Bus Co. Directorate General of Meteorology TÜBİTAK	Integral Conference by the ministries concerned on the control of air pollution in Ankara Explanation on the objectives of investigation and itinerary.
4	March 11 (Fri)	Morning	Group A	Visit National Public Health Institute, Ministry of Health and Social Welfare.	Investigate monitoring system.
		Afternoon	Group B Group A	Visit Turkish Coal Board. Visit Middle East Technical University.	Collecting data and others. Inspect Environment and related facilities.
5	March 12 (Sat)	Morning	Group B Group A	Visit Directorate General of Meteorology. Ankara → Istanbul Visit the Consulate General of Japan.	Collecting data and others.

No.	Date	Time	Group	Itinerary	Item of Investigation
				<p>Visit Istanbul Technical University.</p> <p>Visit Undersecretariat for Environment.</p> <p>Visit private houses.</p> <p>Visit official residence of the governor.</p> <p>Group B Ankara City and its suburb.</p>	<p>Inspect Environment and related facilities.</p> <p>Investigate space heating system for the office building.</p> <p>Investigate space heating at home.</p> <p>Talk on environmental problems in Istanbul.</p> <p>Investigate an outline of the topography.</p> <p>Inspect Patikent housing lot development.</p> <p>Investigate an outline of the topography.</p> <p>Investigate district heating system.</p> <p>Talk with private volunteers including former Minister of Health and Social Welfare.</p>
6	March 13 (Sun)	Morning	Group A	<p>In Istanbul City.</p> <p>Visit New City Developing Cooperative Association (KENT-KOOP).</p> <p>Visit private volunteers of environmental problems.</p>	
		Afternoon	Group A	<p>Istanbul → Ankara</p>	
7	March 14 (Mon)	Morning	Group A	<p>Visit Ministry of Industry and Technology.</p>	<p>Collecting data and others.</p>
		Afternoon	Group B	<p>Visit Mineral Research and Exploration Institute.</p> <p>Visit Urban Planning Bureau, Ministry of Reconstruction and Settlement.</p>	<p>Collecting data and others.</p> <p>Collecting data and others.</p>
8	March 15 (Tue)	Morning		<p>Dinner party hosted by Mr. Refet Erim, Undersecretary</p> <p>Visit Ministry of Energy and Natural Resources.</p>	<p>Collecting data and others.</p>
		Afternoon		<p>Visit Turkish Foundation of Environmental Problem.</p>	<p>Collecting data and others.</p>
9	March 16 (Wed)	Morning		<p>Visit Municipal Electricity, Gas, and Bus Co.</p>	<p>Collecting data and inspecting gas plant.</p>
		Afternoon		<p>Visit Undersecretariat for Environment.</p> <p>Visit Minister Nîmet Özdeş.</p>	<p>Discuss on the contents of request for cooperation.</p> <p>Explanation on environmental administration in Japan.</p>
10	March 17 (Thu)	Morning		<p>Press interview in the official residence of the ambassador of Japan.</p> <p>Reception hosted by the ambassador of Japan.</p> <p>Visit Undersecretariat for Environment.</p>	<p>Exchanging views on the results of investigation.</p> <p>Discussing on the contents of request by the Turkish Government.</p>
11	March 18 (Fri)	Afternoon		<p>Ankara → Frankfurt</p>	
12	March 19 (Sat)			<p>Frankfurt → Tokyo</p>	

Chapter 3 Outline of Conference

3-1 Contents of Request by Turkish Government

The contents of Turkish Government's request conveyed beforehand to us through Japanese Embassy in Ankara had been diversified. For example, Undersecretary for Environment of Turkey requested analysis of the present state and concrete proposal or advice on future actions in short, medium, and long terms, regarding the possibility of the conversion of space heating system, the adoption of district heating system, the introduction of substitutional fuel for lignite, space heating device of higher performance, and filters, etc. in Ankara. There were other requests such as by Minister of Foreign Affairs for advices and cooperation for energy problem, drastic improvement of the city, location of factories, health problems, etc.

As a result of the exchange of opinions during this survey, main points of request were put forth by Turkish Government as a memorandum on the final day of the survey as follows:

REQUEST BY THE TURKISH GOVERNMENT TO THE GOVERNMENT OF JAPAN

- (1) Review and evaluation of the counter-measures for air pollution control in Ankara by the Turkish Government.
- (2) To provide scholarships for training course which are prepared by JICA about environmental subjects.
- (3) To search for the possibilities for the visit of a Turkish team to Japan in order to get a better view and information about Environmental Agency in the field of administration, legislation, techniques and implementations.
- (4) Dispatch of experts in order to establish air monitoring network starting from the settlements at central parts of Turkey and at the industrial regions.
- (5) To search the possibilities of a cooperation in the fields of water pollution and nature conservation.
- (6) To provide publications and reports in English of Environmental Agency and JICA.

3-2 Outline of Proceedings of Discussion

At first, there seemed to be an expectation by Turkish Government for some kind of proposal as a result of this survey, and the initial draft of the request (1) was "Review and evaluation of the information gathered during the preliminary survey of the Anti-Smog Mission". We, therefore, explained again the content and procedure of this kind of investigation by JICA, and it was agreed upon that evaluation should be given based on the result of full-fledged investigation in the future. And then the request (1) was revised as shown in Paragraph 3-1. Although the request by Turkish party covered the whole range of environmental protection administration, we insisted that the investigation should primarily be focused on the measures for air pollution control in Ankara; and we finally found that this also had been accepted by Turkish party.

As to request (2), it was replied that there is a room for examining for acceptance, for it is a problem that could be dealt with by JICA alone. As to point (3), we told them that we are not ready to pay the necessary expense, and Turkish party replied that they would find some other channel such as an international organization. Points (4) and (5) were agreed upon by both of the parties that they should be examined in the future. As to point (6), we replied that we should act promptly as requested.

Chapter 4 Present Status of Air Pollution and Countermeasures against It

4-1 Present Status of Air Pollution

The emission sources of air pollutants and the present state of the ambient air quality in Ankara will be described in this section along with the social and meteorological conditions.

4-1-1 Social Conditions

(1) outline of regional conditions

Ankara's history dates back to 2000 BC in the age of Hittite, but a heavy concentration of population was started in 1923 when Mustapha Kemal, who is called the father of Turkey, moved the capital to this city.

Population of Ankara has been increasing steadily ever since to reach 2 million to be the greatest city in Turkey next to Istanbul.

Citizens of the middle or upper class live in the apartment houses of about five stories high, made of brick, that are concentrated in the central part of the city, and most of the buildings are heated by coal boilers in a central heating system. The exhaust gas from these boilers is regarded as the principal cause of the air pollution.

In recent years, the number of people coming to the city from the countryside to seek their jobs is rapidly increasing. They build their houses in the suburbs of Ankara where they use coal stoves in winter for heating. This is also an important cause of the air pollution.

Ankara is a political city, and practically no factories are existing except some cement and sugar plants that are located in the suburbs; and the principal cause of air pollution is regarded as the use of coal (mostly lignite) for home heating.

(2) population

The population of Ankara was anticipated at 300 thousand when the capital was moved there, but the estimate has been proved to be

far too small as compared with the present figure of 2 million.

Table 4-1-1 Change of Population in Ankara

	1935	1940	1945	1950	1955	1960	1965	1970	1975	1980
Population (10 thousand)	12	16	23	29	45	65	91	124	170	200*

* Estimated Value

The rapid increase in population, along with the rise in the standard of living, (adoption of central heating system etc.), is regarded as the driving force of aggravating the air pollution in Ankara.

The population increase is largely a result of a drift of population from the countryside, 70 - 75 % of the increase being believed to be due to the drift. Fig. 4-1-1 shows a constitution of the population by the age, for men and women, where the number of young men is far larger than that of young women; and it is one of the signs to tell the fact that people are coming to Ankara to seek employment.

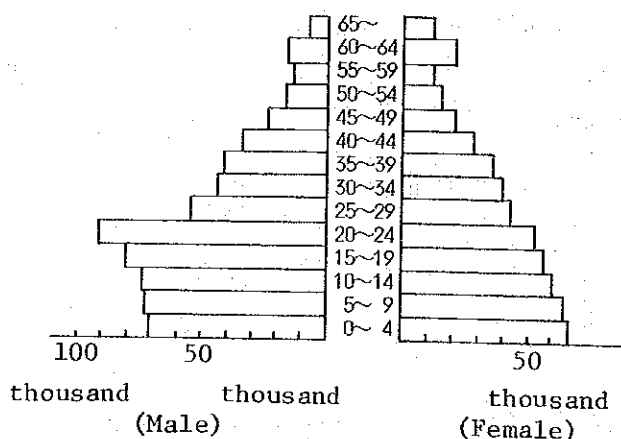


Fig. 4-1-1 Construction of Population by Age (1970)

According to the investigation in 1970, 52 % of the population are classed as a low-income stratum (actual income per month for a home of 1,200 TL or below), 39 % as a medium-income stratum (over 1,200 to 2,750 TL), and 9 % as a high-income stratum (over 2,750 TL). And the low-income stratum mostly live outside 4 km-radius

from the center of the city, the medium-income stratum within 2 - 6 km radius, and the high-income stratus within 4 km radius.

(3) land use

Of the total area of Ankara City that is about 175 km², 89 km² or 51 % is utilized as residential area, 21 km² or 12 % as open space, 11 km² or 6 % as transportation facility, 8 km² or 5 % as military facilities, and 7 km² or 4 % as educational facilities among others. 47 % of the residential area is non-planning area, and 57 % of the citizens of Ankara live there. These citizens belong to the low-income stratum, or are immigrants from other districts, and live there after building their houses on state land and others without permission. But the actual conditions are not well clarified.

(4) industry

Table 4-1-2 shows the number of employees by the industries in 1970.

Table 4-1-2 Number of Employees by Industries

	Agriculture	Manufacturing industry	Construction	Transportation	Commerce	Service and others	Total
Number of employees	17,800	53,597	27,487	26,048	33,364	238,112	396,408
[%]	4.5	13.5	6.9	6.6	8.4	60.1	100

As the population in Ankara was 1.24 million in 1970, only about 30 % of the population were nomically employed; but the actual figure is believed to have been larger than the above, because many people work without registration.

(5) transportation

Transportation in Ankara mostly depends on roads with the exception of railway running east west across the city. Means of public transportation are busses operated by EGO (Municipal Electricity, Gas, and Bus Co.), omnicoach called "Dolmus", taxis, etc.

The number of private cars are estimated at about 100 thousand including those for industry.

Table 4-1-3 The Number of Cars and Passengers (1982)

Transportations	Number of Cars	Number of Passengers per Day
1. E G O (Municipal Electricity, Gas and Bus Co.)	899	800,000
2. Dolmuş		
a. Station Wagon	500	100,000
b. Mini-bus	1,300	450,000
3. Taxi	6,000	250,000
4. Other Busses		
a. Shuttle service (governmental)	500	50,000
b. Commercial bus	130	100,000
5. Private car	100,000	700,000
6. Rail way		50,000
7. Others		300,000
Total	108,159	2,800,000

4-1-2 Weather

(1) outline

Ankara is located at the center of Anatolia Plateau in a basin surrounded by mountains at a height of 900 m above the sea level. The latitude is 40°N, which is about the same as that of Akita City in Japan. The climate is that of steppe with small rainfall, and the land sparsely covered with green. The climate is also continental with a large difference in temperature, the highest at 40°C and the lowest at minus 25°C in the past. (See Table 4-1-4.)

Table 4-1-4 Meteorological data in Ankara

	Average for last 45 years)												
	1	2	3	4	5	6	7	8	9	10	11	12	Average
Average temperature [°C]	0.3	1.0	4.7	11.2	16.1	20.0	23.1	23.3	18.4	12.9	7.7	2.5	11.8
Highest record of temperature [°C]	16.4	20.4	28.5	31.6	34.4	36.4	38.8	40.0	35.7	33.3	25.3	20.4	Max. 40.0
Average number of days in a month with highest temperature 30°C or above				0.2	1.2	5.7	16.1	17.4	5.0	0.3			Total 45.9
Average number of days with lowest temperature minus 10°C or below	3.9	3.1	1.0								0.2	1.5	Total 9.7
Average relative humidity	78	75	66	57	57	50	42	40	46	56	70	77	60
Rainfall (mm)	18.1	37.7	37.4	35.7	50.6	30.3	13.2	8.5	18.2	21.7	28.5	47.1	Total 367.0
Number of fog appearing days	5.6	3.7	2.9	1.8	0.4	0.3	0.2	0.1	0.4	1.4	3.9	5.1	Total 25.7

Directorate General of Meteorology operates weather observation at 10 observatories in and around Ankara. The vertical profile of temperature is observed twice a day at 0:00 and 12:00 Greenwich standard time by means of radiozonde at one station.

(2) wind

North wind prevails throughout the year, occupying 60 % of the wind. West wind follows, occupying 25 %. The velocity of wind is about 3 m/s in any direction.

(3) temperature and humidity

The average annual temperature in Ankara is 11.8°C, the maximum monthly average temperature is in August at 23.3°C and the minimum in January at 0.3°C. The difference in temperature is large due to the continental climate, and the cold in winter is especially severe. The number of days with minus 10°C or lower minimum temperature is about 10 in a year, and the number of days with maximum temperature not exceeding 0°C is about 15 in a year.

The humidity is commonly considered low, owing to the climate in steppe with small rainfall; but according to the data by Directorate General of Meteorology, the annual average relative humidity is about 60 % and relative humidity in winter is about 75 %. Fog is often observed in winter, about 5 days in a month.

(4) stability of atmosphere

Fig. 4-1-2 shows the maximum mixing height in monthly average. As it is lower in winter, air pollutants are difficult to be dispersed fully. And this makes the air pollution in winter worse.

Fig. 4-1-3 shows the thickness of inversion layer. It is thick in winter and allows to pollutants to stay there, making it difficult to diffuse.

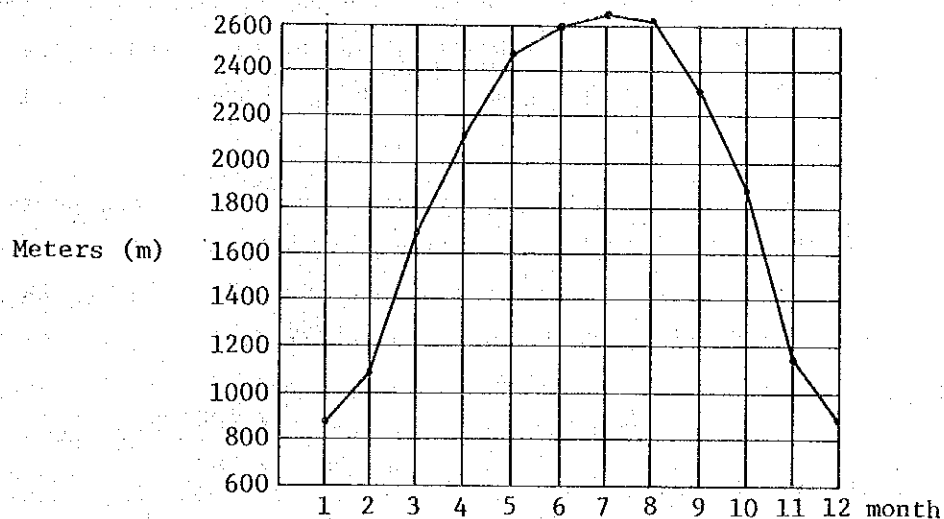


Fig. 4-1-2 Annual Variation of Monthly Average of Maximum Mixing Height

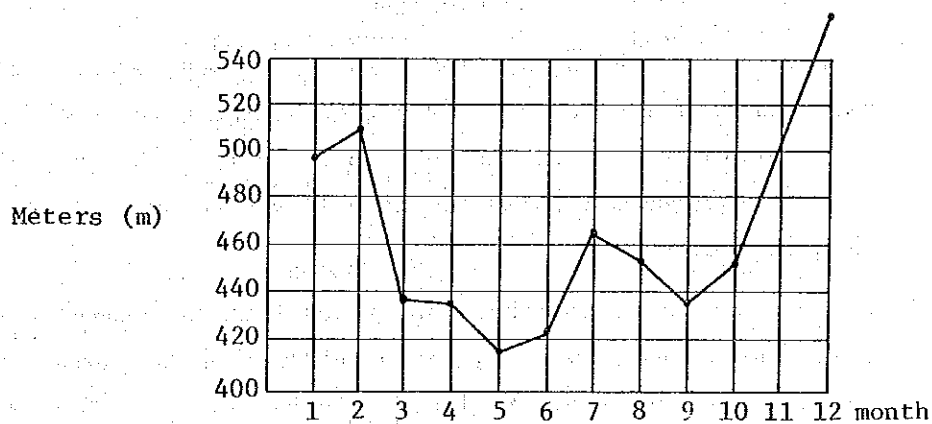


Fig. 4-1-3 Annual Variation of Monthly Average of Inversion Layer Thickness

4-1-3 The Emission Sources of Air Pollutants

(1) stationary sources

Factories in Ankara emitting a large amount of exhaust gas are only several plants of cement, sugar and gas industries, and they are located in the suburbs of Ankara. Therefore, the principal cause of air pollution is the burning of coal for space heating.

People of the middle or higher class live in the apartment houses

in mostly five-storied buildings concentrated on the center of Ankara where domestic lignite is used as fuel for the central heating boilers. The lignite fired boiler inspected by the contact mission has no stoker, and lignite is directly thrown into the furnace by hand.

On the other hand, people living in the one or two-storied houses of bricks, called Gecekondu (meaning a house built overnight) that are built by the immigrants or low-income people on the state land and others without permission burn lignite in their stoves for room heating. The number of those people was 51 % of the total population in 1970, but the present number is not known.

The burning of lignite is believed to be the primal cause of air pollution in Ankara, but the sources are very small in scale. Therefore no measurement of the concentration of pollutants in exhaust gas has been made. The consumption of lignite by said boiler for apartment houses was told to be about 100 tons in 6 months, and the boiler of this scale in Japan is on the borderline for regulation by Air Pollution Control Law.

In addition to the smoke from lignite burning, smokes from heavy oil boilers for space heating and gas burners for cooking at home may contribute, to some extent, to the air pollution. However, their effect on air pollution is believed to be small as compared with that of coal.

As no measurement for the exhaust gas from the cement plant, sugar plant, etc. has been made, the actual emission conditions are not clear. Although they are located in the suburbs, the amount of exhaust gas is estimated to be very large; and pollution at least in a limited area should be doubted and investigation seems to be necessary.

Consumption and prices of fuels are given as follows for each of the coals, liquid fuel and gaseous fuel.

a) coals (lignite, coke, and briquette)

The annual consumption of coals in Ankara is about 1.2 million tons, of which about 1 million tons is supplied by Turkish Coal Board and the rest, about 200 thousand tons, by private suppliers, the detail of which is not clear.

Table 4-1-5 shows the consumption and price of lignite, coke, and briquette.

Table 4-1-5 Consumption and Price of Lignite, Coke and Briquette

	Year	Lignite	Coke	Briquette	Total
Consumption (Ton)	1970	240,132	128,818	6,474	375,424
	1975	425,706	81,765	7,293	514,764
	1980	952,664	56,679	15,532	1,024,875
	1981	931,683	12,248	14,700	958,631
	1982	850,954	71,779	13,642	936,375
Price (TL/Ton)	1982	7,400	14,800	12,400	

Table 4-1-6 shows the amount of reserve, production and quality of coal by the mine. All of the coal except one from Zonguldak are lignites of low grade, and Beypazarı, that is the nearest to Ankara, produces extremely low grade lignite with sulfur content as high as 2.8 - 4.6 %.

Table 4-1-6 Quality of Coal by the Mine

Name of mine	Reserve (1,000t)	Production (t/Y)	Moisture (%)	Ash (%)	Calories (Kcal/kg)	Sulfur content (%)	Distance from Ankara (km)
Tunçbilek	220,335	3,614,952	11~24	5~21	3,800~6,200	1~1.7	350
Seytömer	228,588	4,700,162	27~40	14~40	2,200~3,300	1~2	340
Soma	510,000	1,797,801	13~27	21~33	2,300~4,100	0.8~4.7	580
Beypazarı	400,000	147,644	22~32	12~35	2,800~3,500	2.8~4.6	110
Zonguldak	1,394,424	1,921,092	2~3	4~37	7,400~7,800	1.2	284
Alpagut	20,640	594,905	19	12	4.100	1.6	250

b) liquid fuel

Fuel oil, (mixture of heavy oil and light oil) is used exclusively for heating boilers and gasoline and light oil are used for automobile. Their consumption and price are shown in Table 4-1-7. The fuel oil consumed in the sugar plant and the cement plant is not included in the figures in Table 4-1-7.

Table 4-1-7 Consumption and Price of Fuel Oil, Gasoline and Light Oil

	Fuel oil		Gasoline		Light oil	
	Consumption (ton)	Price (Kr/ℓ)	Consumption (ton)	Price (Kr/ℓ)	Consumption (ton)	Price (Kr/ℓ)
1970		156	934,535	150~195		125
1975	289,557	150~156	1,760,958	280~345	18,810	247
1980	260,663	1,250~2,684	1,674,232	3,300~5,800	21,458	2,050~3,600
1981	256,823	2,700~3,700	1,666,273	6,000~8,100	16,406	4,200~5,000
1982	256,300	4,650~5,012	1,714,490	10,200~11,000	16,406	6,860

$$(Cf : Kr = \frac{1}{100} TL)$$

c) gaseous fuel

LPG and city gas are used mostly for cooking and hot water supply at residences. City gas is manufactured from coal and heavy oil. Table 4-1-8 shows the consumption and prices of LPG and city gas.

Table 4-1-8 Consumption and Price of LPG and City Gas

	L P G		City gas	
	Consumption (ton)	Price (TL/kg)	Consumption (m ³)	Price (TL/m ³)
1970	217,696	35	56,789,287	-
1975	541,073	35	57,749,066	1.24
1980	746,695	200 ~ 510	64,918,042	13.50
1981	792,465	580 ~ 715	66,689,443	15.75
1982	789,938	980	69,000,000	21.25

(2) mobile source

Cars of various kinds are the mobile source of air pollutants in Ankara. As shown in Table 4-1-3, the number of cars in Ankara is about 100 thousand, which is far less than that in Japan. (The smallest number in Japanese prefecture, Shimane, is 250 thousand cars for population of about 800 thousand, and in Tokyo about 3.2 million cars for population of about 11 million.)

Therefore, the effect of exhaust gas from the mobile sources cannot be so large; but the property of the exhaust is not fully investigated and leaded gasoline is used in general, and some intelligent people expressed their anxiety for the pollution by lead.

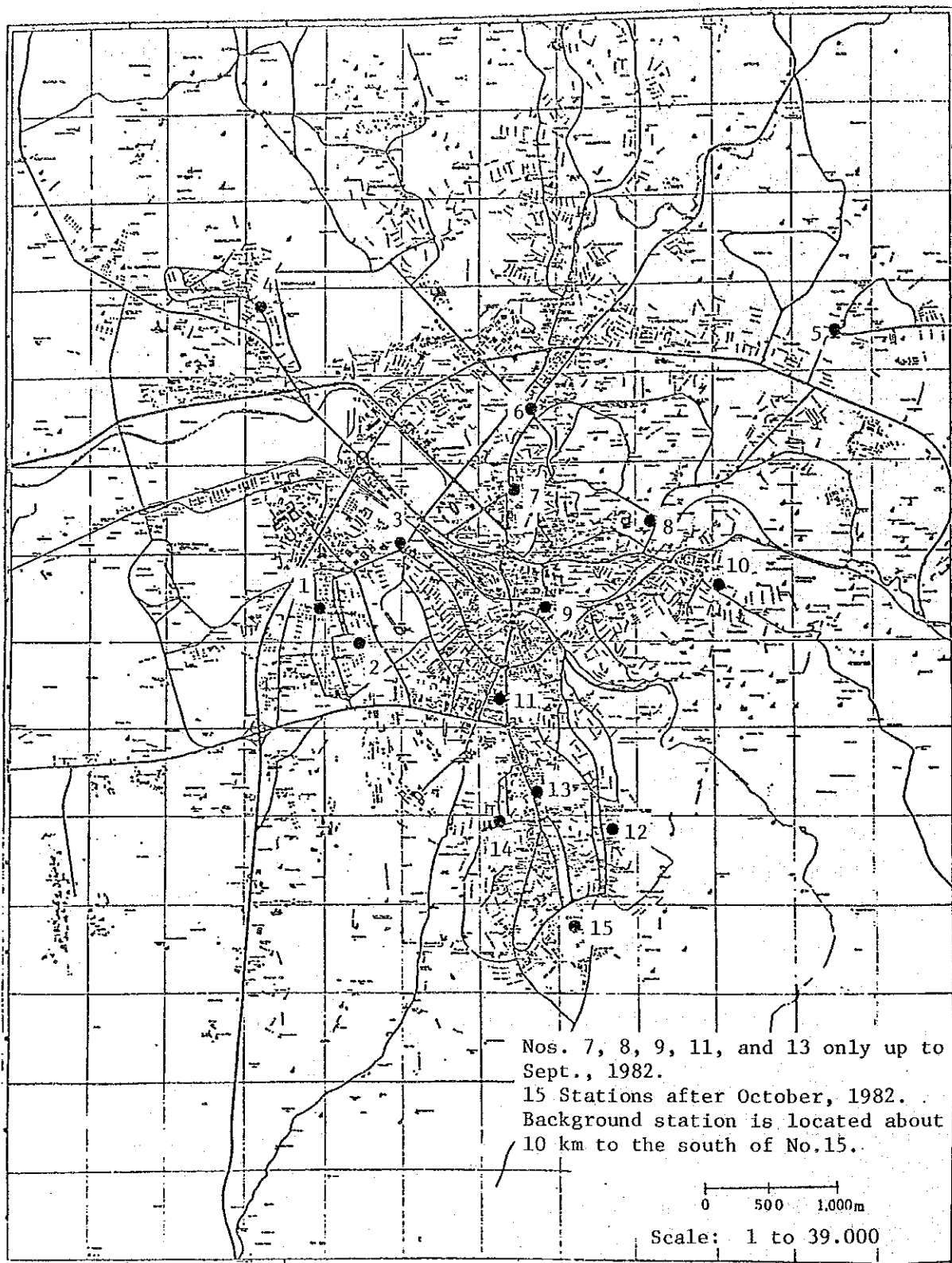


Fig. 4-1-4 Location of Monitoring Stations

4-1-4 Present Status of Air Quality

The air quality in Ankara is grasped by 15 monitoring stations located in the city, one station for the monitoring of background level in the suburbs of Ankara, and a movable station on a car. (cf. Fig. 4-1-4)

(1) monitoring items and methods

SO₂ and particulate matter are constantly monitored at the stations and daily values are obtained. The movable station can determine SO₂, H₂S, TS, THC, NO, NO₂, CO, O₃, and particulate matter.

The measurement methods are as follows:

15 monitoring stations	... SO ₂ ... titration by Na ₂ CO ₃
	particulate matters ... light absorption
movable station SO ₂ , H ₂ S, TS, THC ... flame photometry
	NO, NO ₂ , O ₃ ... chemical luminescence
	CO ... infrared ray absorption
	particulate matter ... light absorption

(2) monitoring result

Table 4-1-9 shows the monthly mean concentration of SO₂ and particulate matter in Ankara.

The data after October, 1982 are mean values for 15 monitoring stations, while those before that date are mean values for 5 stations.

The annual average of SO₂ concentration is in the range of 197 µg/m³ - 257 µg/m³, and the level is about the same as one in Kawasaki-city, Japan in 1965. Although seasonal change in Kawasaki was small, in winter and is considerably low in summer. SO₂ concentration level in Ankara in summer is about the same as that in Tokyo at present.

On the other hand, the annual average concentration of particulate matter is about the same as that in Tokyo in 1965. It is remarkably high in winter while low in summer as is the case with SO₂.

The high concentration in winter is evidently caused by the fuel for space heating, as well as the unfavorable meteorological conditions. The concentrations of SO₂ and particulate matter in

Table 4-1-9 Trend of Monthly Average Concentration
of SO₂ and Particulate Matter (1978~1982)

[$\mu\text{g}/\text{m}^3$]

year pollutant month	1978		1979		1980		1981		1982	
	SO ₂	P.M.	SO ₂	P.M.	SO ₂	P.M.	SO ₂	P.M.	SO ₂	P.M.
Jan.	428	104	551	108	558	181	433	130	698	292
Feb.	400	86	366	60	462	155	387	117	555	207
Mar.	329	80	289	77	367	127	316	91	437	125
Apr.	238	59	106	38	161	75	178	70	197	82
May	76	28	30	17	64	44	128	44	112	46
Jun.	58	21	25	19	46	35	97	39	73	47
Jly.	40	15	21	23	38	27	63	31	55	32
Aug.	33	12	31	23	39	27	55	28	53	36
Sep.	32	20	45	37	44	37	55	61	67	53
Oct.	37	30	51	38	56	73	71	90	145	121
Nov.	589	128	377	164	272	146	375	191	358	270
Dec.	502	120	473	180	387	123	364	150	337	219
Average	230	59	197	66	208	87	219	87	257	127

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Temperature (°C)	-7.0	-9.6	-5.5	-6.7	-6.0	-4.0	-3.0	-5.5	-6.0	-7.0	-6.2	-5.8	-7.0	-10.5	-10.0	-0.5	0.0	-8.0	-11.6	-7.0	5.1	0.0	-2.0	-0.2	-6.8	-13.0	-9.0	-12.0	-4.2	-1.0	-2.7
Wind direction		W	W	SE	S						SW	NW	NE	NE	SW	NE	W	NW	NE	NE	SW	W	NE			NE					
Wind speed (m/s)	0	4.0	5.0	1.0	2.0	0	0	0	0	0	0.5	2.0	1.2	5.0	2.0	1.2	1.0	3.0	1.2	6.0	5.0	2.0	0.6	0	0	6.0	0	1.0	0	0	0
Relative humidity(%)	81	92	69	96	83	93	82	92	91	92	90	94	90	97	84	78	95	87	81	77	74	82	80	67	67	87	76	92	85	91	83
Weather *	C	C	C	C	C	C	C	C	C	C	C	C	Fg	Fg	Fg	C	C	Fg	Fn	C	R	C	C	Fn	Fn	Fn	Fg	Fg	C	C	C
Inversion layer	None	None	None	None	None	None	None	700~1200m	1500~3000m	600~800m	450~850m	0~800m	500~750m	500~1350m	800~1100m	0~800m	None	0~500m	0~1000m	0~600m	600~800m	700~800m	None	1900~2300m	2300~2800m	1250~1800m	800~1600m	0~700m	500~1400m	None	None
SO ₂ (µg/m ³)	**	293	264	248	280	211	272	198	200	219	217	256	194	206	389	307	363	442	493	573	311	328	320	312	262	327	570	668	411	373	458
SP (µg/m ³)	**	131	111	107	111	97	167	138	102	122	123	177	124	132	240	153	174	201	304	357	142	163	159	148	131	157	284	381	231	234	361

* C: Cloudy, Fg: Foggy, Fn: Fine, R: Rainy

** Mean value for 15 monitoring stations

Fig. 4-1-10 Meteorological Conditions and Air Pollution in January, 1983

January, 1983 are shown in Table 4-1-10 along with meteorological conditions. The meteorological conditions of the days of higher concentration are such that inversion layer is formed nearer to the ground or there is no wind. The conditions of the air pollutants being filled in the atmosphere without diffusion can be easily imagined.

Table 4-1-11 Concentration of Pollutants in the Ambient Air by Monitoring Stations

(Average value in Jan., 1983)

No. of Station in Fig. 4-1-4	Name of Station	SO ₂ (µg/m ³)	Particulate matter (µg/m ³)
1	Bahçelievler	477	249
2	Emek	318	172
3	Tandoğan	335	163
4	Yenimahalle	203	141
5	Siteler	228	151
6	Yıldırım Beyazıt	224	194
7	Ulus	320	204
8	Cebeci	289	171
9	Sıhhiye	324	180
10	Abidinpasa	419	212
11	Kızılay	423	230
12	Küçük Esat	354	195
13	Kavaklıdere	527	237
14	Aşağı Ayrancı	332	182
15	Çankaya	172	87

Table 4-1-11 shows the mean values of SO₂ and particulate matter concentrations measured at monitoring stations in January, 1983. The concentrations in Çankaya, where the presidential office is located, is the lowest; and this is due to the place being at a height to command the center of Ankara and the air pollutants can

rise to the height with difficulty under the formation of inversion layer.

The concentrations are comparatively low in Yenimahalle and Sıteler that are located off the center of Ankara. Because of the absence of factory emitting smoke and soot in the central part, it is estimated that the pollution is caused principally by the fuel for space heating at home.

Table 4-1-9 shows that the rise in concentration in spring towards autumn is increasing year after year; and this is probably due to the growing urban activities by the rapid increase in population.

4-2 Countermeasures against Air Pollution

4-2-1 Introduction

The effect of oil crisis was serious in Turkey. Under such a energy situation, it is quite natural that Turkey could not follow the same route for their control of air pollution taken by countries in Europe and America in the period of prosperity. The actions taken by Turkish Government cover, under acceptance of their inevitable dependence on lignite for the space heating energy even in the future to a considerable extent, drastic and long-term actions such as utilizing lignite after treatment and expansion of oil use and short-term actions such as contrivances in existing space heating facilities and emergency refuge in the case of aggravation of air pollution expected by the meteorological conditions in very carefully thoughtout measures; and the directions selected by them seem to be mostly correct. The following is a summary of the actions against air pollution in Ankara taken at present and in the future for each of the concrete items.

4-2-2 Establishment of Undersecretariat for Environment in Turkey and the Outline of the Program to Solve the Air Pollution Problem of Ankara

The Undersecretariat for Environment was established in the Prime Minister's Office, based on the Government ordinance, on 12th of August, 1978, as the Office to manage problems concerning environment.

Fig. 4-2-1 shows the organization.

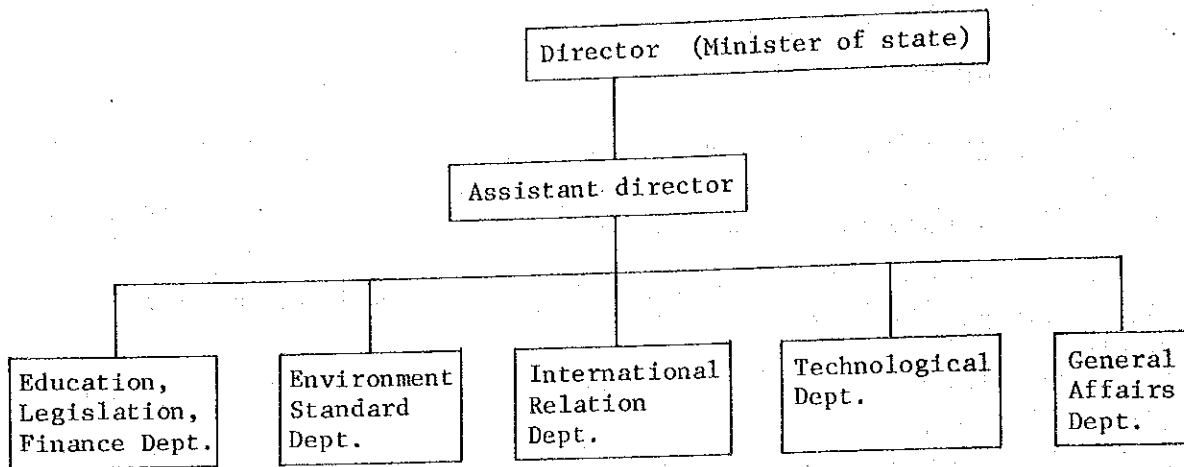


Fig. 4-2-1 Organization Chart of Undersecretariat for Environment

The office is responsible for coping with environmental problems as coordinating with concerning authorities, at the same time, undertaking to plot and implement the special project for the severely polluted area. In those projects, air pollution control project in Ankara is a important theme.

"The Program for Decreasing the Air Pollution in Ankara", prepared by the office, is, as it were, a master plan for air pollution control in Ankara in future.

- (a) To solve the problem of pollutions from heatings:
- Provision of fuels with better qualities
 - Provision of sufficient and better burning of fuels
 - Provision of insulation at the buildings for heating to decrease the fuel consumption
- (b) The measures to decrease the pollutant effects of the sources other than heatings (the industries and the traffic):
- Strict controls and follow-ups at these sources
 - Afforestation studies
 - Modernization of monitoring system for pollutions
 - Provision of public participation to "the Program"

(1) short-term program

The target of "the Program" is to decrease the polluting emissions approximately 50 % by immediate implementation of the short-term Program.

- (a) There are supplied 175,000 tons of coke, 25,000 tons of coke briquette, 680,000 tons of lignite from Tunçbilek of which 450,000 tons washed and as the fuel-oil 250,000 tons of special kind of oil with lowest viscosity and minimum sulphur during the heating season this year. Thus, it is forbidden to supply or to bring any other kind of fuel into the city, and it is strictly controlled.
- (b) To provide sufficient and better burning of fuels, the controls are made systematically at the buildings for the betterment of central heating boilers and furnaces and the stokers trained for this purpose.
- (c) To begin filtrations, the results of the studies of the Ministry of Industry and Technology for determining the relevant filter types are expected.
- (d) To decrease the fuel consumption (by insulation at the buildings for heating), due to the new paragraphs of the Construction Regulation, it is made compulsory to take measures in this manner at the new buildings constructed after Jan. 1st 1983.
- (e) To decrease the pollutant emissions from the Cement Factory, the electrical filter is operated. The injector calibration and the exhaust controls are made by teams at the traffic.
- (f) For the betterment of microclimatic conditions, increasing the photosyntheiss and thus lessening the pollutant emissions' effects esp. on vitals, studies are continued to increase the green areas in the city, esp. the trees that are green during the winters, as well.
- (g) At 17 monitoring stations, which are provided by IBRD credits, the air pollutants are continuously monitored at the localities with certain distances from each other, which are determined due to their representativeness for the city. These monitoring localities are Abidinpaşa, Cebeci, Siteiler, Y. Bayazıt, Yenimahalle, Emek, Bahçelievler, Ulus, Tandoğan, Kızılay,

Aşağı Ayrancı, Çankaya, Küçük Esat, Kavaklıdere and Sıhhiye. Reference locality for clean air monitoring is at Gölbaşı.

- (h) In spite of the above mentioned measures, if the level of air pollution increases due to the unfavorable atmospheric and climatic conditions, then there is made and decided on the action plan for each of the following levels of pollutions (as the average levels in 24 hours):

Table 4-2-1 Emergency Levels of Air Pollution

level \ pollutant	SO ₂	Particule (Unit: µg/m ³)
The first level	700	400
The second level	1000	600
The third level	1500	800
The fourth level	2000	1000

Detail of the action plans are as follows;

First step:

- a) All stoves and central heaters should be fired between 5-6 A.M. and 14-15 P.M. hours. The temperature in official buildings should not be over than 18°C, and public houses not over than 20°C.
- b) During the holidays (except hospitals, boundinghouses, terminals etc.) stoves and central heaters will not burn. If there is a technical difficulties for getting-off the fire, firing should be at minimum level.
- c) All cars given out a black-smoke from their exhaust pipes should be put out of traffic.
- d) All waste materials should not be burned in the garden, street or avenues.

Second step:

- a) In addition to the first step precautions, second and third class non-sanitary installations should reduce their smoke-emissions about 50 %.
- b) Stoves and central-heaters should be burned 3 hours in the

morning and 3 hours in the afternoons, altogether not over than 6 hours in a day.

Third step:

- a) In addition to the second step precautions the personal cars ended with single and double figures, should run in the street according to the single or double dates of the week.
- b) Primary and secondary schools should be closed.
- c) First class non-sanitary installations should reduce their emissions 50 %.
- d) All stoves and central-heaters should be fired only 3 hours in a day.

Fourth step:

- a) In addition to the first, second and third steps, all schools, official departments and working places, should be closed.
- b) All traffic should be stopped (except officials, military, security, firebrigade, cars carrying useful materials, ambulances, cor-diplomatic and taxi cars).
- c) First, second, third-class non-sanitary installations should be stopped (except subsistence and necessity installations for the people).
- d) All stoves and central heaters should be extinguished.
- e) All medicines in the hospitals should be reserved for treating the patients.
- f) All ambulances (officials and personal) should be collected under the order of the general director of health, in Ankara.

(i) To create and to develop public conscious and participation the following measures have been taken:

- At primary and secondary schools, this subject is put into the curriculums.
- Together with the Voluntary Organizations, there are made

meetings, seminars and panel discussions, etc.

- There are published brochures to give the right and the complete informations about the fuels, the ways of burning and the insulation methods for heatings.

(2) long-term examination subjects

The above mentioned are of the short-term. In addition, long-term examination subjects are as follows:

- (a) Due to the Loan Agreement for "Ankara Air Pollution Control Engineering Project" with IBRD (World Bank), an international awarding of the contract will be made for gasification of the lignites at Beypazari. (See 4-2-4 (2))
- (b) There is a project for producing domestic gaseous fuel from naphtha for heatings esp. at the districts at which the air pollution is the most. (See 4-2-4 (1))
- (c) In the central districts of Ankara at which the air pollution problem is the most, the vertical growth is prohibited to cease the increase of the population density. (See 4-2-4 (3))

4-2-3 Details of Tentative Countermeasures

(1) existing countermeasures concerning coal supply

Heating season in Ankara is from November through March. Taking extremely heavy atmospheric pollution in the heating season of 1981-1982 into consideration, Turkish Coal Board (TKI) took measures to supply better quality coal energy last season (1982-1983).

Throughout the year, 80 % of thermal coals (lignite, cokes, briquette, etc.) is being supplied to Ankara by TKI, and the remaining 20 % is supplied by private traders. But in the last heating season, in order to maintain the sulfur content of coals below one percent, coal supply by private traders were prohibited, and TKI supplied all of the coals. The amount of coals supplied by TKI is shown in Table 4-1-5. And the amount of coals supplied during the last heating season (1982-1983) is expected to be around a million tons.

The actions taken in the last heating season for supplying coal of better quality were (1) increasing import of steel manufacturing

coke from USA and Argentina, (2) supplying washed lignite, and (3) supplying hand picked lignite. The briquette shown in Table 4-1-5 was manufactured from the coke pulverized in processing and transportation of coke but not from lignite.

Sulfur content of lignite is about 1.5 % on average, and it reaches as high as 7 % in some cases. Therefore, the sulfur content as low as 1 % or less by washing or hand picking is effective to some extent. The result of analysis of coals supplied by TKI is given in Table 4-2-2.

Table 4-2-2 Result of Quality Analysis of Coals (Average)

Item	Lignite	Coke	Briquette
Moisture (%)	16	1	8.25
Ash (%)	23	15	23
Calories (kcal/Kg)	4,200	5,400	5,300
Sulfur Content (%)	1.5	1.0	0.78

TKI manages from production through supply to consumers of coal. At the foot of the TKI office building of 22 stories constructed recently, there is a terminal for lignite and coke arriving by train and being transferred onto trucks to be shipped into the city. A briquetting plant is located nextdoors.

(2) recommendation to use oil

After the first oil crisis in 1976, new installation of oil boiler was prohibited, but at present, new installation of coal boilers in the city of Ankara is prohibited since November, 1982.

No tightening of fuel oil supply in Ankara is seen at present, and its supply is going to be increased, it is said; and a strict control in distribution is enforced so that the anticipated amount of oil be surely consumed in Ankara. The fuel oil used at present is a blend of light oil (diesel oil) and heavy oil, and the sulfur content of the blend is 1 % or less, while that of heavy oil is about 4 %.

The amount of fuel oil consumed in Ankara is about 250 thousand tons a year.

In this connection, Batikent Project, construction of a large residential district going on at present, will be explained.

Batikent is under construction in a valley extending to the west of Ankara Basin, and it will not be a bed town of Ankara but an independent city to be established along with a new industrial complex that will provide the inhabitants with employment. The planned population is 300 thousand, or 60 thousand families, and the area 1,000 ha. Ground leveling for the project has already been finished, and construction of buildings was started in 1979. The undertaker of construction is KENT-KOOP, that is a union.

Excellent heat insulators will be used in apartment houses, and some buildings will use solar energy for energy saving. However, the main system of space heating is a central heating by means of a boiler which is similar to those used in Ankara at present, the only difference being the larger scale and higher thermal efficiency. According to the plan, 150 central heating plants will be constructed. The plants will be situated underground for the beauty of city, and the exhaust gas led to a height slightly higher than that of the nearest buildings by means of ducts and discharged into atmosphere.

The fuel to be used for the boilers is a problem. Undersecretariat for Environment demands Batikent to install oil burner as is the case in Ankara, but KENT-KOOP declares to use coal boiler, because Batikent is located to the west of Ankara and will not seriously affect the air pollution of Ankara in view of the prevailing wind in winter. The final conclusion has not been reached yet.

(3) guidance, etc. as regards the method of using fuel for space heating

Of the actions carried forwards by Undersecretariat for Environment, there are modest but carefully thought out measures as follows.

a) restrictions for igniting space heating devices:

The restriction for the time of ignition in emergency (see 4-2-2(1)(h)) is meant for prevention of soot formation that is strong in ignition.

b) training boiler technician:

Boilermen are trained for prevention of soot formation and combustion with high heat efficiency.

c) restriction of high building in the central part of the city:

The bill was proposed to the congress on March 21, 1983 and was expected to pass. The bill is a temporary measure for four years, limiting the height of the buildings on a lot of area 4,000 m² or smaller up to four stories and a rooftop. No limitation is given to a lot larger than 4,000 m² in area. The measure is meant for limiting population increase in the urban district, but the action is temporary; and it can be regarded that the environmental side is urged to take fundamental action against air pollution within the given four years.

4-2-4 Future Actions

(1) increased supply of town gas

The city gas is supplied in Ankara solely by Municipal Electricity, Gas and Bus Co. (EGO) that has two gas plants, one at Maltepe in the central part and Onia-Gegi in the suburb of the city. The former is an extremely old plant treating sub-bituminous with maximum production capacity of 6,300 Nm³/h, or 45 million Nm³/year; and it is used for the base load. The latter has a capacity of 5,000 Nm³/h x 2 units, or 15 million Nm³/year; and it is used for peak loads.

EGO is planning construction of a new plant next to the existing plant in Onia-Gegi, and its anticipated capacity is 300,000 Nm³/day x 2 units which is somewhat larger than the consumption for cooking and hot water supply in the region of gas supply at present. Ego is also planning to improve the existing plant in Onia-Gegi to have a capacity of 200,000 Nm³/day x 2 units. After the completion, EGO can supply gas for space heating in 2,000 buildings, and the old plant in Maltepe will be abolished. The new plant in Onia-Gegi will use naphtha as the raw material and start operation in 1986, while improvement of the existing plant completed in 1988.

Table 4-2-3 Supply of Gas in Ankara (Planned)

Year	Supply capacity Nm ³ /day	Demand		Number of Premises by gas heating
		Cooking and Water heating Nm ³ /day	Space heating Nm ³ /day	
1985	250,000	250,000	-	-
1986	600,000	300,000	300,000	12,000
1987	900,000	400,000	500,000	20,000
1988	1,000,000	500,000	500,000	20,000

EGO is going to increase its amount of gas supply and intends to supply gas for space heating in the future, while the gas is used at present only for cooking and water heating (bath, etc.). (As will be explained later, gasification of lignite is being planned, and there is a hope for supply of gas of low price in a long term, but the plan for production from naphtha is for the near future.) Here naturally arises a question on whether there is an economic incentive for the conversion into gas. According to the explanation by EGO, remodeling of coal boiler into gas boiler will cost 100 - 150 thousand TL and it is not too large when the saving of personelle expense for boilerman and others is taken into account. The expected production cost of gas is 6.82 TL/1,000 kcal. EGO has no plan for expansion of supplying area in the future. Because the area out of supply at present is mostly illegal area for living, and supply of gas cannot be approved administratively.

(2) lignite gasification plan

According to the plan advanced by EGO with enthusiasm, lignite will be gasified and supplied to Ankara by means of a pipeline. The plan has just been started, and concrete design was not available. Specialists from the World Bank are participating in the project. The lignite to be used is produced from the coal mine in Beypazari, about 100 km to the northwest of Ankara; and the gasification plant will be constructed near the mine. The reserve of coal is estimated at 400 million tons and the production is 148 thousand tons

a year. The sulfur content is as high as 4 %.

Technologies for processing lignite were studied in the past for manufacture of coke and briquette but without success. The start of the third project by Turkish Government in spite of the past failures would show the difficult economic situation in the country that must depend on her domestic source of energy.

(3) arranging forecasting system of emergency

Emergency actions for air pollution are enforced as already explained. In order to make them more effective, the level of air pollution should be forecasted on the day before according to the forecast of the meteorological conditions. Based on this concept, Directorate General of Meteorology is making efforts to establish a system of air pollution forecast.

The accuracy of the forecast will be as simple as to tell whether the level will be as high as that of the emergency, but the forecast is very important as one of the actions against air pollution.

4-2-5 Other Research and Development

Turkish Government has tried to develop several processes for supply of lignite in an easier form of use. Already in 1966, studies for manufacture of briquettes from lignite was started by Mineral Research and Exploration Institute and a project for establishing a coking plant in Seytömer in 1976. Further in 1980, a project for construction of a lignite gasification plant near Beypazarı was started. A considerable part of 6 million dollars of loan from the World Bank in three years from 1980 to 1982 as the fund for "Ankara Air Pollution Control Engineering Project" is appropriated.

(1) development of briquette manufacturing technology

Mineral Research and Exploration Institute has been studying for enhancing the quality of domestic lignite and for prevention of air pollution in Ankara. The technological target was in manufacturing fuel of high physical strength, homogeneity, water proof, and high calories. As a result of study on the domestic lignite, it was concluded that briquetting for manufacture of smokeless fuel is of advantage. The main features of the briquette are as follows:

- a) Lignite of fine size produced in mining can be utilized.
- b) Briquette is highly marketable and convenient in use.
- c) Briquette is less dusty in transportation and storage than raw lignite.

Briquette is manufactured by heating fine lignite of 5 mm ϕ or smaller size to 350 - 450°C. Bituminous or subbituminous coal is plastic at that temperature and can be formed into briquette by pressing, but addition of a binder is necessary in case of lignite.

The difficulty in the project was to make the lignite plastic without mixing bituminous coal, etc., it was told.

In the first stage of the study, laboratory tests were conducted. After experiments on several kinds of domestic lignite, characteristics of the briquette were decided. In the next stage, a pilot plant of a capacity of 200 kg/hr was introduced for industrial operation. In this stage, Turkish Scientific and Technological Research Council, Turkish Coal Board, and Mineral Research and Exploration Institute worked in cooperation.

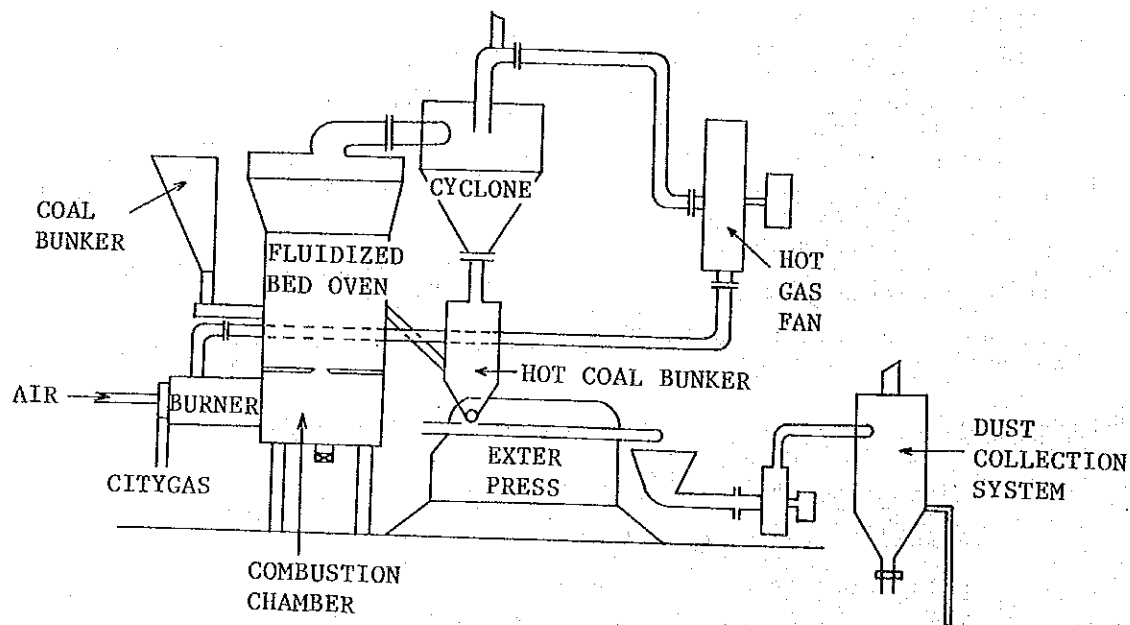


Fig. 4-2-2 Process Diagram in Briquette Manufacturing Plant

The diagram of the process of briquette manufacture in the pilot plant is shown in Fig. 4-2-2. The lignite is heated in a fluidized bed oven. The lignite as raw material in the plant is 6 mm ϕ or smaller in size and contains 30 - 40 % moisture. The fluidized bed oven has a capacity of 500 kg/hr and is heated by city gas and/or distillation gas. Of the particles of lignite heated to 400°C, the larger ones are with drawn using the over flow, and the fines through a cyclone, both to be eventually collected in the hot coal bunker. Those are finally pressed into briquettes of a shape of prism 4 cm x 6 cm x 1 cm in size.

According to the result of feasibility study compiled in May, 1978 by Mineral Research and Exploration Institute, it is feasible technically and economically to construct a briquette manufacturing plant of annual capacity of 150,000 tons in Seytömer. The report says that the production cost of briquette is 1,144.15 TL/ton as of 1979 which is lower than the price of coke which is 1,600 TL/ton.

Sulfur is eliminated during briquette manufacture, and the sulfur content of the briquette is about 0.9 % while that of the raw material lignite is 3.5 %. The calorific power of the briquette is 5,200 kcal/kg that is 60 % higher than that of raw material lignite, 3,300 kcal/kg.

The undertakings for which fund is accommodated by the World Bank include designing, construction, and operating of a pilot plant of a capacity of 2 - 3 tons/hr, the amount of fund required being 3 million dollars. Turkish side spends 3 million dollars, too; and a total of 6 million dollars are appropriated as budget. The plant seems to be successful in the stage of experiment, but no commercial plant has been realized because of an economical reason.

(2) coke manufacturing plant project

The coke manufacturing plant was advanced by Turkish Coal Board since 1976 by introduction of the technology from Otto Ltd. in West Germany. Otto Ltd. is a first class coal plant manufacturer in Europe but the technology for lignite utilization was not developed enough according to the appraisal of an officer of Turkish Coal Board in charge.

The plant was completed in 1976, but accidents and troubles took place successively; and it was abandoned after operation for less than a month. Improvement of the plant was attempted spending 35 thousand dollars of the 6 million dollars from the World Bank in vain, and there is no hope of the operation being re-opened yet.

Fig. 4-2-3 shows a general idea of the plant.

(Note)

"Ankara Air Pollution Control Engineering Project" is undertaken by accommodation of fund to Turkish Government by the World Bank as much as 6 million dollars in total in three years from 1980 to 1982 under conditions of 10 year repayment. The object of the project is to develop a process for manufacturing smokeless fuel from lignite or investigate technology for supplying other clean fuel from lignite. More concretely, the five themes are considered as follows.

- (1) Evaluating possibility of applying the technology that has been established worldwide to manufacture of smokeless fuel from lignite produced in Turkey.
- (2) Assistance to improving the coke manufacturing plant
- (3) Assistance to construction and operation of pilot plant for manufacturing briquette (2 - 3 t/hr).
- (4) Examining possibility of manufacturing fuel gas from lignite, regional space heating, geothermal heating, desulfurizing petroleum, supplying propane gas, etc.
- (5) Accommodation of fund that is necessary for urgent actions against air pollution such as procuring air pollution monitoring equipment, etc. (supplementing assistance from UNDP)

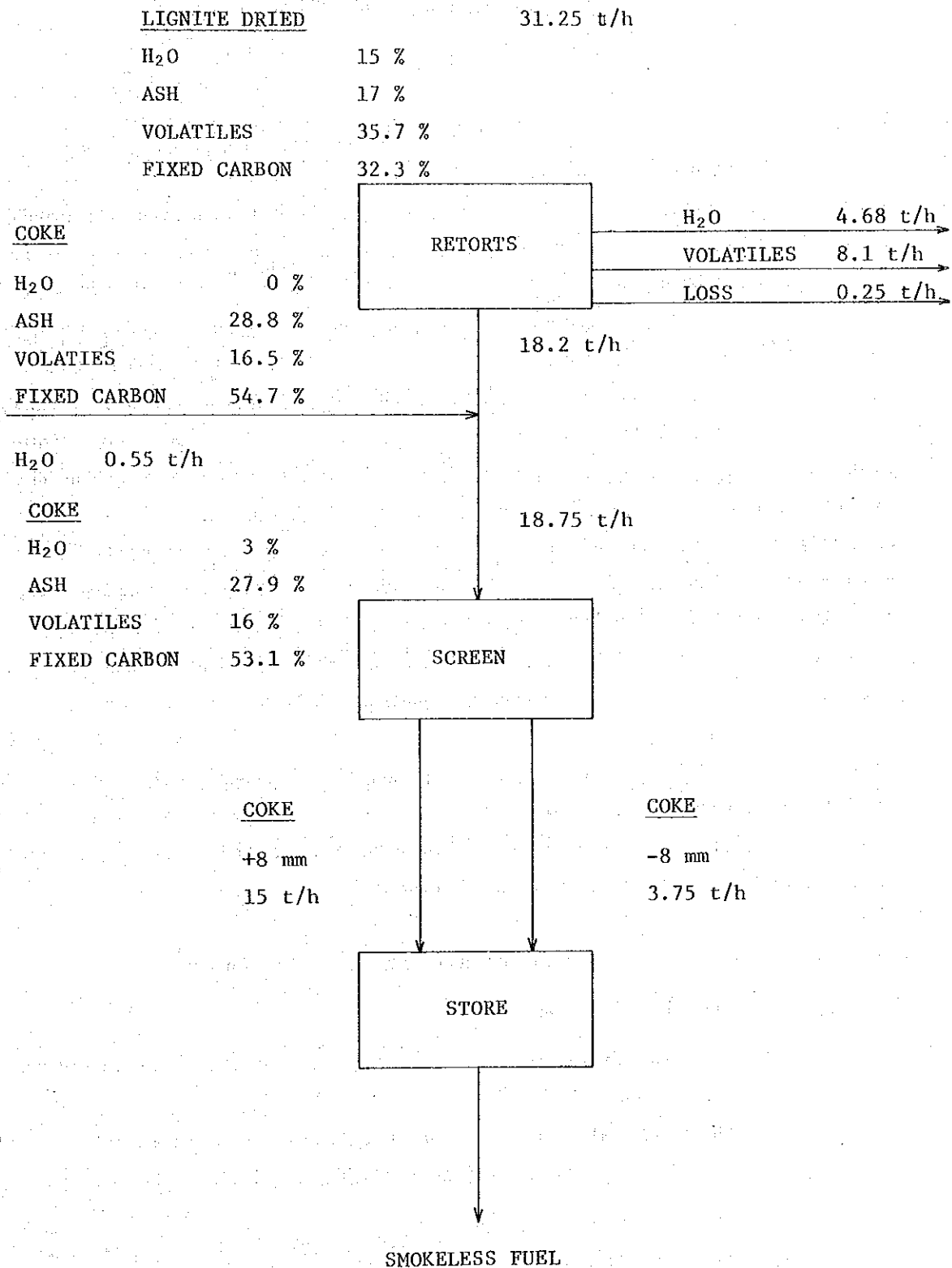


Fig. 4-2-3 Process Diagram for the Coking Plant

Chapter 5 Proposal on the Basic Policy in Execution of Full-Fledged Investigation

5-1 Basic Policy for Execution of Full-Fledged Investigation

The full-fledged investigation shall be conducted based on this preliminary survey and on the Turkish Government request (1). In other words, various actions being taken by Turkish Government at present for relieving the air pollution in Ankara shall be reviewed as far as quantitatively in view of the effect of improvement, energy-economy aspect, etc., to reach an integral evaluation. Here it is not very meaningful to make similar tests which were examined by Turkish Government financed by World Bank, as followup on individual items such as manufacture of coke and briquette from lignite. It must also be avoided to place too much stress on the drastic measures and make proposals on actions of small possibility of execution such as radical change in urban planning, changeover of fuel completely to kerosene, etc., without understanding the economical and social reality. As has been repeatedly stated by the Turkish party during this survey, the investigation shall be advanced keeping in mind that the action shall be executable without spending so much time and money.

If the restrictions above can be accepted, the full-fledged investigation to follow should be advanced based on use of lignite as fuel basically in order to clarify the limit of the effect available for each of the measures; and the content will be as follows:

[1] Measurement survey of ambient air and emission sources

(1) Meteorological survey

- a) the wind direction and velocity, temperature and humidity on the ground
- b) the vertical distribution of the wind direction and velocity, and the temperature in upper air

(2) Ambient air quality

- a) sulfur oxides
- b) particulates

- (3) Survey of emission factors
 - a) emission factors of sulfur oxides
 - b) emission factors of particulates

[2] Evaluation of possible countermeasures for the mitigation of air pollution from the technical and economical aspects

To analyse and evaluate quantitatively the probable reduction rate of air pollutant emission attained by the following measures, and to estimate the costs necessary for those measures.

- a) increase of the consumption of fuel oil in the central area of Ankara
- b) increase of the supply of city gas in the central area of Ankara
- c) adoption of the district heating system equipped with flue gas treatment units
- d) promotion of the heat insulation of buildings
- e) utilization of primitive lignite quality improvement methods (washing, coal-cleaning by gravity, etc.)
- f) increase of the consumption of higher quality coal (bituminous, coke, etc.)
- g) application of the flue gas treatment units to plants
- h) others (improvement of fuel-combustion technology in boilers, etc.)

[3] Study of social conditions

To study the following social conditions, based on the existing data.

- a) estimation of the future figures of supply and demand of various kinds of energy
- b) estimation of the future projection of social indicators closely related to air pollution (population, houses, plants, automobiles, etc.)
- c) grasping institutional or customary restrictions including life style, if any

[4] Analysis of the air pollution by the simulation model method

- a) analysis of the air pollution in Ankara, by the simulation model method, taking into account such natural conditions as topography or meteorology, and social conditions, such as types or distribution pattern on emission sources.
- b) analysis on effectiveness of adoption of measure such as early warning system for emergency and some other measures for mitigation of air pollution considering the characteristics of air transportation and dispersion in and around Ankara.

[5] Preparation of measures for the air pollution control

Presentation of the reasonable methods for air pollution control among at the medium term (approximately ten years) based on the findings of above [1]-[4] and preparation of implementation programme.

5-2 Recommendations for Execution of Full-Fledged Investigation

It is important in view of the critical conditions of air pollution in Ankara to complete the investigation and give conclusion in a short time as far as possible. On the other hand, severe pollution is limited to winter, and the investigation should be made at least for a period of winter. Consideration of these points makes us to conclude that the investigation should desirably be started in winter 1983 when the heating season is started to be completed before the start of heating season of 1984 or the end of it at the latest and the report will be presented to Turkish Government soon after the investigation.

Owing to the organization of Turkish Government being complicated and actions against pollution being taken by many offices and organizations, it seems desirable that the representative organ should be decided at Undersecretariate for Environment. Collection of data and arrangement for investigation should be made through the office for a smooth progress of investigation.

5-3 Background of the Proposed Plan for Full-Fledged Investigation

For the better understanding of the background of the proposed plan for investigation as shown in 5-1 above, we would like to give our impression on the actions taken by Turkish Government against air pollution in Ankara

within the range of our knowledge obtained in this preliminary survey.

The actions already taken or to be taken by Turkish Government seem to be mostly correct in the direction. However, the following points can be indicated. Firstly, the attempt to develop plants for manufacture of coke or briquette from lignite or for gasification of lignite has not been successful even in Europe where they have much experience in utilization of coal. It is not generally accepted yet and seems to be of too much risk to be applied to the low grade material at present. Secondly, other actions are not very much difficult technically and can be regarded effective at least qualitatively; but practically nothing has been made for assessment of the quantitative effect on reduction of air pollutants. Especially, the air pollution in Ankara can only be solved after understanding the rapidly expanding population and the industrial trend, and mobilizing every possible means that can be carried out. Therefore, the most reasonable combination of measures shall be found out from the view points of technology and economy and time schedule for its execution established. Participation of several administrative organizations is inevitable in carrying out the projects for solution of air pollution, and this is another reason why the operation above is indispensable.

The investigation plan proposed in Paragraph 5-1 is meant for dissolving said second problem as the main object. One hour values of pollutants concentration will be available when the full-fledged investigation is carried out; and this is not only necessary development of atmospheric pollution simulation model for indication of the effect of action for relieving the air pollution but also useful for grasping the conditions of short-time appearance of high concentration and for further enriching the emergency actions to protect human health. In this connection the environmental standards for sulfur dioxide and suspended particulate are set in Japan as one hour values as well as 24 hour values.

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