Type of Vehicles by States and Regions (as of January 2016)

Sr.	State/Region	Private car	Passenger car	Truck (light Duty)	Truck (Heavy Duty)	Other	Two wheelers	Three wheelers	Traw lergi	Machinery	Total
1	Head office	1204	9	17		1	51	-	-	-	1282
2	Nay Pyi Taw	12217	1201	1667	1054	2819	92396	199	509	164	112226
3	Kachin	3620	159	322	1946	224	113947	4737	2467	16	127438
4	Kayah	1239	146	386	353	124	63280	501	241	36	66306
5	Kayin	2042	93	528	560	319	91763	900	763	68	97036
6	Chin	300	35	29	67	24	10472	15	13	-	10955
7	Sagaing	7083	1331	4431	4153	1403	506392	5640	1180	111	531724
8	Tanintharyi	2679	436	1276	1101	370	171004	2209	1236	106	180417
9	Bago	5427	834	2344	3268	1963	384948	8427	1216	68	408495
10	Magway	3998	763	2272	3200	565	385460	4627	892	9	401786
11	Mandalay	62568	2891	37653	14579	10422	1374534	24476	19086	154	1546363
12	Mon	3218	267	2639	1280	474	247720	5829	1300	11	262801
13	Rakhine	1084	147	317	233	114	37731	1675	226	-	41527
14	Yangon	320056	15368	114428	26625	30365	228748	3740	2858	524	742712
15	Shan (Taunggyi)	9648	354	3111	2133	626	223025	582	1909	30	241418
16	Shan (Kyaington)	4589	150	1597	523	150	114816	5618	2708	28	130179
17	Shan (Lashio)	7416	284	4414	2527	797	127515	2563	3488	46	149095
18	Ayeyarwady	4201	1116	934	1184	596	362768	1873	3513	5	376190
Total		452697	25584	178365	64786	51356	4536570	73611	43605	1376	5427950

Mandalay city has three industrial zones –
zone 1, 2 and 3.
Zone 1 began in 1990,
zone 2 was opened in 1998 and
zone 3 from 2003.
One plot measures 40 feet by 60 feet, and it is possible for a business to span several plots.

	Total	Industrial	Housing	Warehouse	Vacant	other
Zone 1	1758	695	551	56	445	11
Zone 2	1598	829	353	56	260	100
Zone 3	252	77	6	19	141	9

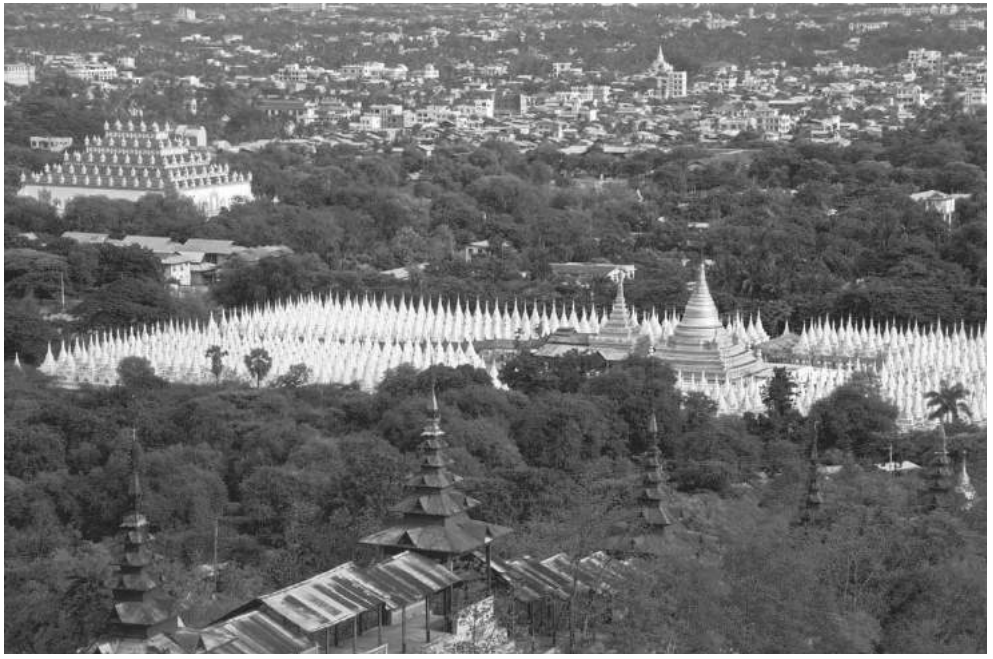
Source:
Mandalay Industrial Zone Governing Committee

Mandalay Region Government

Mandalay City Development Committee

AMBIENT AIR QUALITY MONITORING SYSTEM INTRODUCTION AND TRAINING IN MANDALAY CITY

Min Aung Phyoe
Staff Officer
Cleansing Department



Monitoring Unit

- Haz Scanner Model-EPAS
- Automatic Sensing
- Sensors
  - PM10
  - CO
  - NO
  - NO2
  - HC
- Record Count- Every minutes
- Battery Type

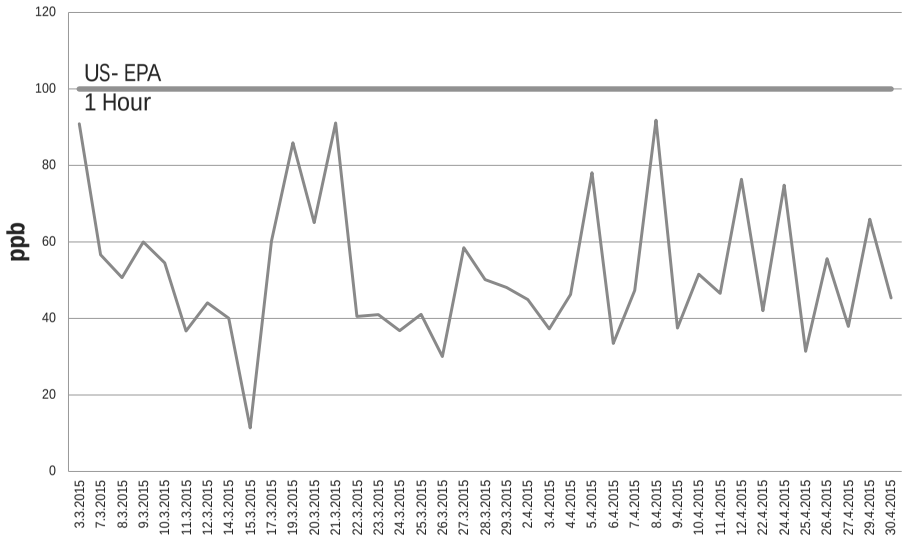
Air Quality Monitoring Points Selection

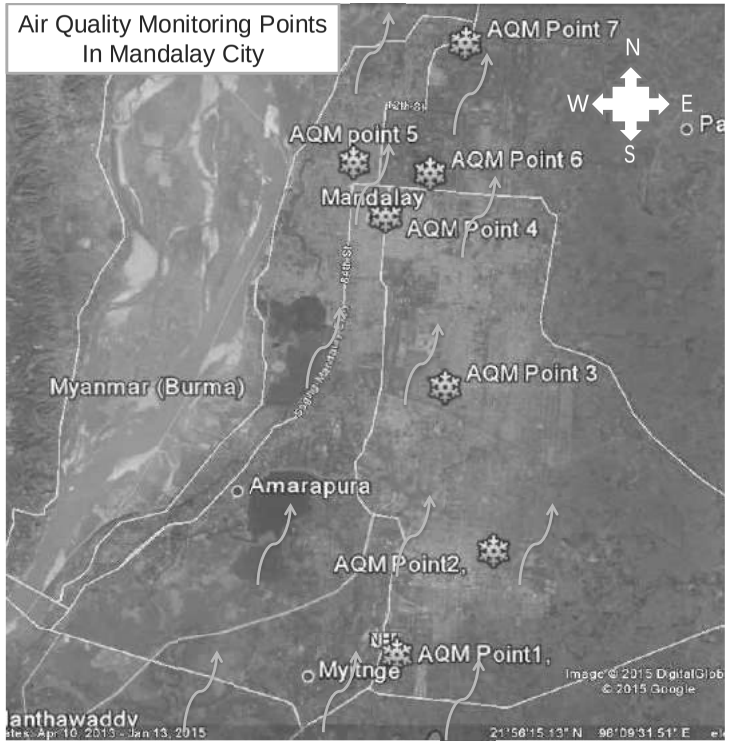
Mandalay City

❖ In the Summer and Raining season, the wind is mostly south to north, totally 9 months per annum.

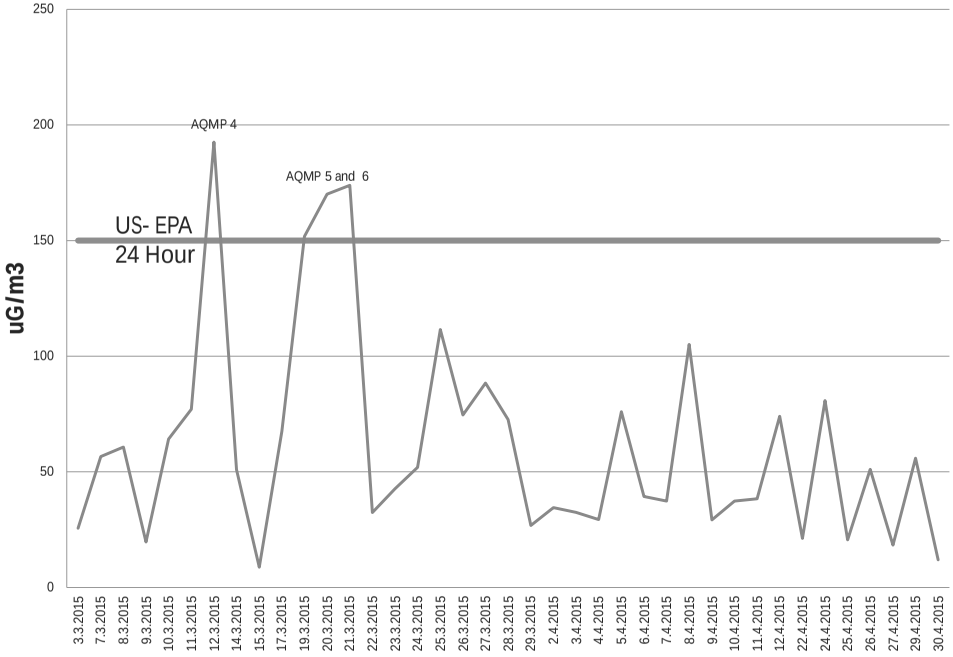
		Location	Characteristic
1	AQMP 1	Southern Edge of City	Public Area,
2	AQMP 2	Inside of the Industrial Zone	Industrial Area
3	AQMP 3	MCDC's Worker Housing	Residential Area
4	AQMP 4	Yadanabon Plaza	Public Area
5	AQMP 5	Conner of 84 and 26 roads	Traffic Jam
6	AQMP 6	City Hall	Residential Area
7	AQMP 7	Top of the Mandalay Hill	Cultural

NO2

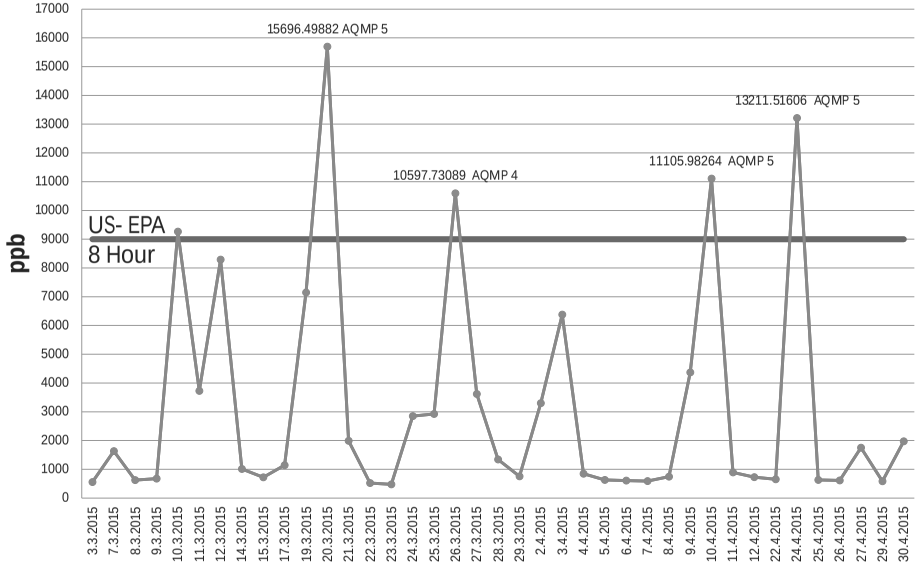

ppb
US- EPA
1 Hour


Air Quality Monitoring Points
In Mandalay City
AQM Point 7
AQM point 5
AQM Point 6
Mandalay
AQM Point 4
AQM Point 3
Myanmar (Burma)
Amarapura
AQM Point2,
AQM Point1,
Myinge
N
W
E
S

PM10


uG/m3
US- EPA
24 Hour
AQMP 4
AQMP 5 and 6

CO

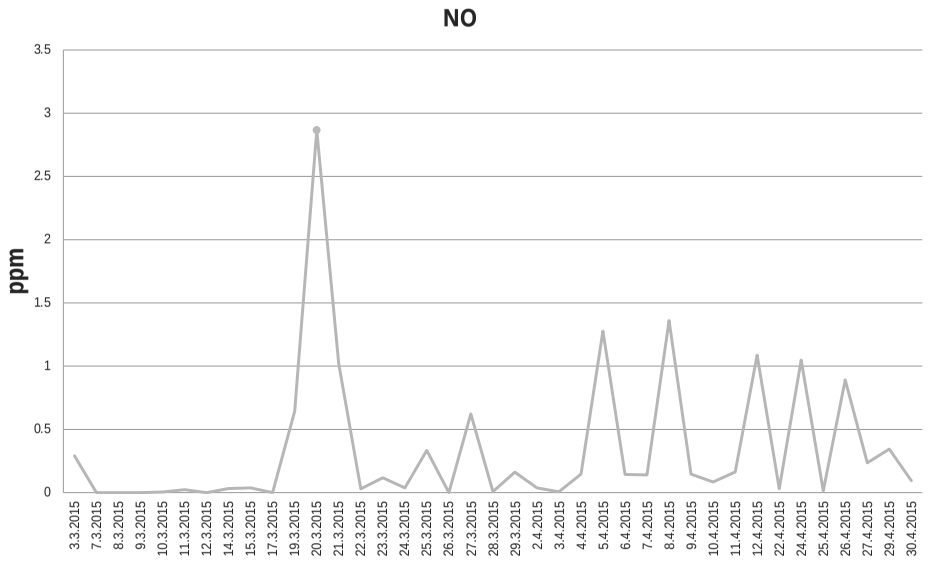

ppb
US- EPA
8 Hour
15696.49882 AQMP 5
10597.73089 AQMP 4
11105.98264 AQMP 5
13211.51606 AQMP 5

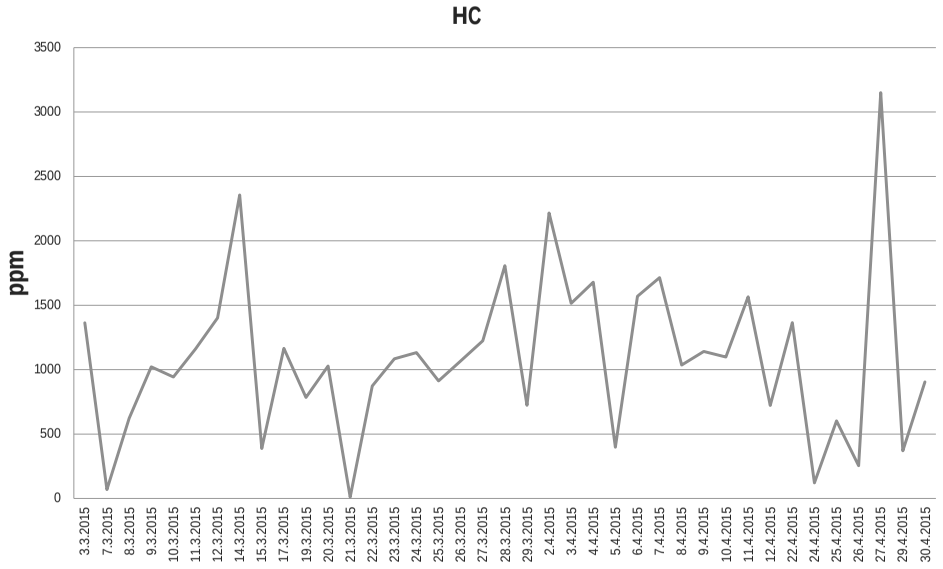
Upgrade the Monitoring Unit

- SO2
- CH4
- O3
- CO2

Needs

- Organization Structure
- Capacity Building
- Cooperation
- Budget





Thank you very much.

Some Aspects of Air Quality in Mandalay

Win Maung
Chairman
Myanmar Environment Institute (MEI)

The main objective

- To get baseline ambient air quality data of Mandalay city.

Survey Location

There are three air quality monitoring locations.

1. *MAQN 1 (within the compound of Industrial Zone-2)*

2*. near Myaing Hay Wun Park, northern part of Mandalay city*

3*. Inside the MOEP compound, junction of 26th street and Yangon-Mandalay Express Road*

Figure 1 present maps of the monitoring **locations of air, noise and water quality.** (MAQN-1, MAQN-2 and MAQN-3).

Table 1-12 Ambient air quality results. (November to April)

Sampling Location	MAQN-1						V
Parameter	Nov.	Dec.	Jan.	Feb.	March	April	Guideline
SO_2 (µg/m^3)	77.57	177.26	125.79	189.61	145.34	56.6	20
NO_2 (µg/m^3)	64.86	35.58	48.31	89.73	96.89	93.4	200 (1 hr)
CO (mg/m^3)	0.97	3.42	0.46	0.77	2.2	0.64	NA

Sampling Location	MAQN-2						W
Parameter	Nov.	Dec.	Jan.	Feb.	March	April	Guideline
SO_2 (µg/m^3)	64.90	73.26	106.00	59.57	27.58	28.6	20
NO_2 (µg/m^3)	64.86	48.53	139.58	158.61	120.25	150.4	200 (1 hr)
CO (mg/m^3)	0.91	0.6	0.47	0.81	0.78	0.71	NA

WHO Standard limit:

PM10 - 50 (µg/m3)
PM2.5 - 25 (µg/m3)
NO_2 - 200(µg/m3)
SO_2 - 20(µg/m3)

EU Standard limit :

CO 10 (mg/m3) (EU);

Sampling Location	MAQN-3						WI
Parameter	Nov.	Dec.	Jan.	Feb.	March	April	Guideline
SO_2 (µg/m^3)	58.58	104.85	85.65	150.46	122.81	34.26	20
NO_2 (µg/m^3)	69.37	76.87	80.17	84.29	90.83	94	200 (1 hr)
CO (mg/m^3)	2.01	5.9	1.06	0.74	1.72	2.18	NA

-Sulfur dioxide (SO2) concentration in all 3 stations were higher than the guideline value (20 µg/m3) of WHO standard.

-NO2 and CO concentration are normal and within the standard limit of WHO and EU respectively

Findings:

-The air pollution concentration vary spatially and temporally
-changes in meteorological and topographical condition.
-vehicles, industries, domestic sources and natural sources.

Prevention of Air pollution

Trend:
-numbers of vehicles and Industries will increase in Myanmar

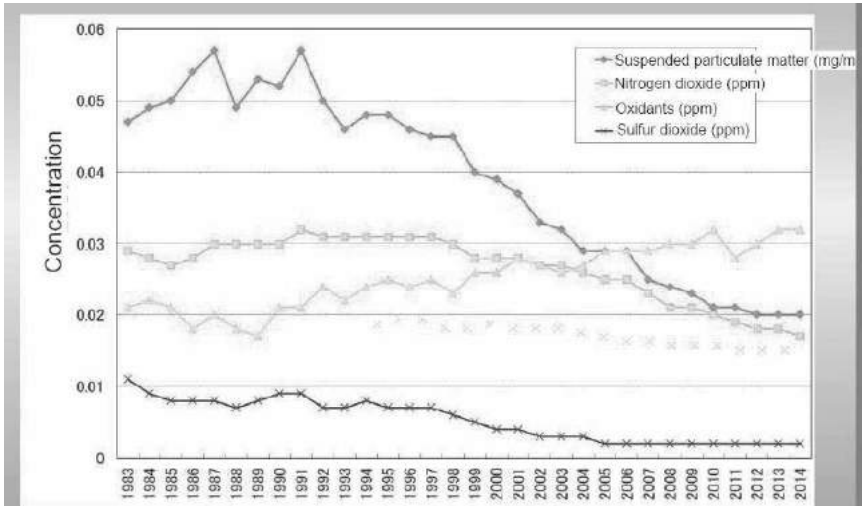
Need:
-Monitoring
-Simulation
-Mitigation

Air quality monitoring as studied in Japan during the visit

Future Plan of MEI

-To conduct air quality monitoring in collaboration with Environmental Conservation Department

1) Yangon, 2)Bago, 3) Pathein



Concentration of air pollutants in Tokyo

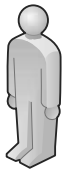
Purpose of Monitoring

1. Planning
- New environmental regulation

2. Action
- Implementation of the law

3. Check
- Review effectiveness. Inspection

4. Action
- Do modification & improvement



Why?

Corporation : HORBA,Ltd.
Division : Process & Environmental Segment
International Sales Office

Name : Tomo Enokibori

Importance of Monitoring for the Conservation of Environment

Example of Air Monitoring

Date : 25th Feb 2016

When do we start monitoring

- There is no pollution for sky, river, sea
- What will happen after construction?

History - Ambient -

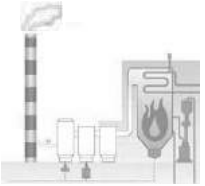
1950～: A lot of Asthma, Bronchitis Patients
1968 : Air Pollution Act (Manual Monitoring)
1970～: Oxidize Smog
1974 : Total Volume Control
(Continuous Monitoring)
=> Concentration * Flow rate

Ref : KANAGAWA ENVIRONMENTAL RESEARCH CENTER Website

1. Ambient Monitor

2. Transportation
↓ For Automotive

3. Stationary source
↓For Stack Emission



4. Fuel monitoring
↓ Low sulfur content

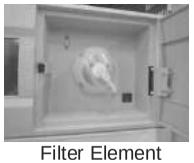
Ref : Wikipedia Heavy Oil

Example of Ambient Analyzer

AP-370 series

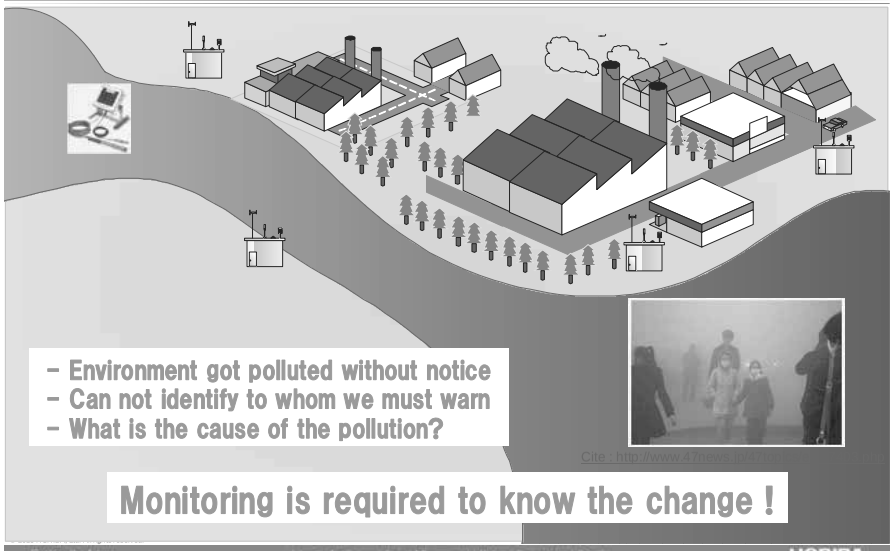
NOx	APNA-370
SO2	APSA-370
O3	APOA-370
CO	APMA-370
PM10, 2.5	APDA-371
THC	APHA-370
H2S	APSA-370+CU-1
NH3	APNA-370+CU-2

LCD Touch Display



Filter Element

When do we start monitoring

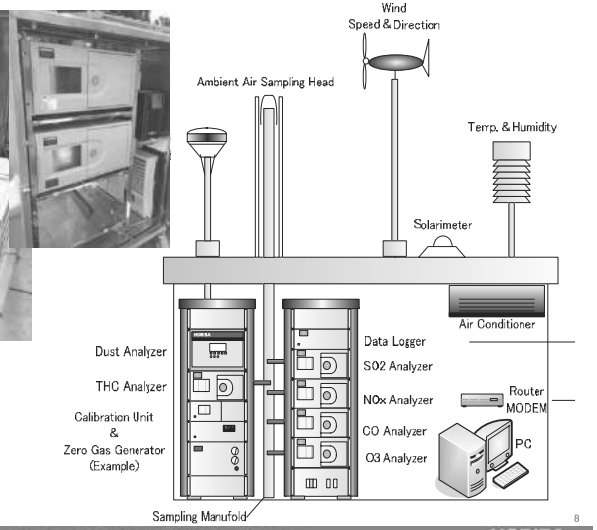


- Environment got polluted without notice
- Can not identify to whom we must warn
- What is the cause of the pollution?

Cite : http://www.47news.jp/47...

Monitoring is required to know the change !

Example of Ambient Quality Monitoring System



Fixed Type AQMS

There are several analyzer for monitoring

Exhaust Gas Analyzer MEXA-584L

For inspection of automobile

...ble Gas ...nalyzer ...PG-300

For inspection of factory

Ambient Monitor AP-370

Stack Gas Monitor ENDA-5000

For continuous monitoring

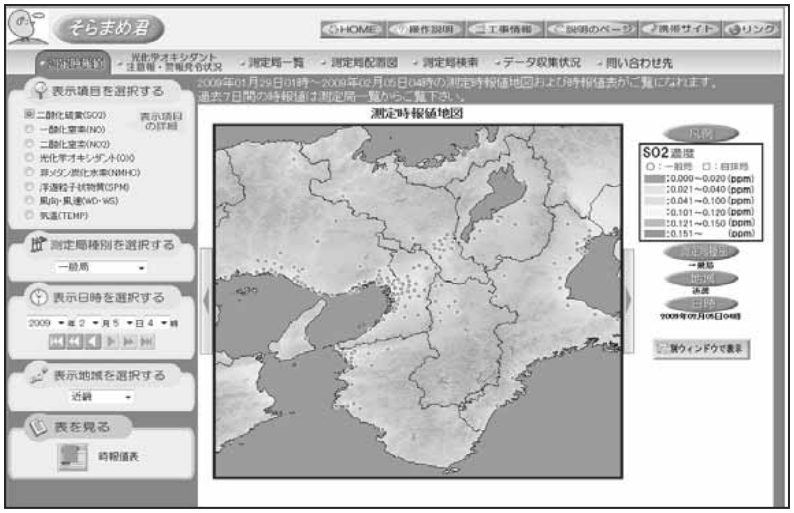
Sulfur Content Analyzer SLFA-60/600

To check sulfur content in fuel

Analyzer = help monitoring

Utilization of Monitoring Data

Japan



Example of Ambient Quality Monitoring System

Mobile Type AQMS

Utilization of Monitoring Data

Singapore

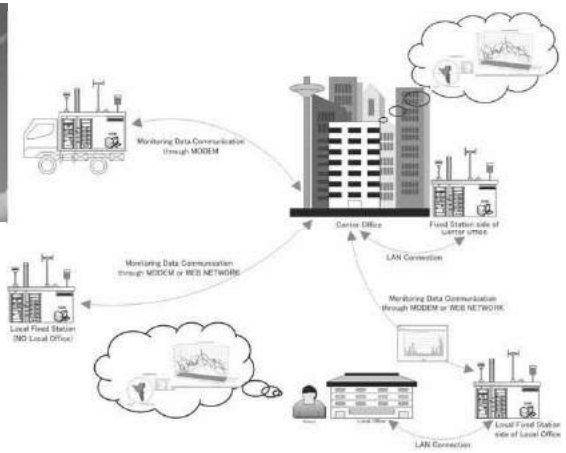
For past 24 hour PSI reading click here. For historical PSI reading click here.

24-hr PSI: 41 - 51, 3-hr PSI: 40 at 6am on 15 Feb 2016

Note: Air quality based on 24-hr PSI is as follows:

PSI Value	Air Quality Descriptor
0 - 50	Good
51 - 100	Moderate
101 - 200	Unhealthy
201 - 300	Very unhealthy
Above 300	Hazardous

Utilization of Monitoring Data

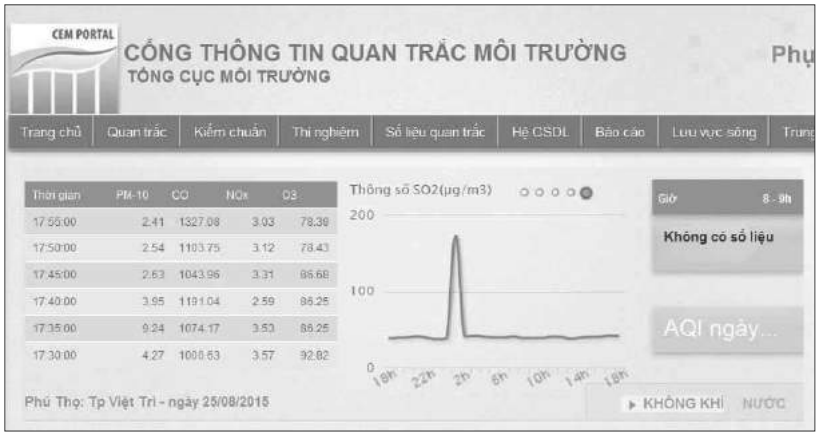


Important Point for Precise Ambient Monitoring

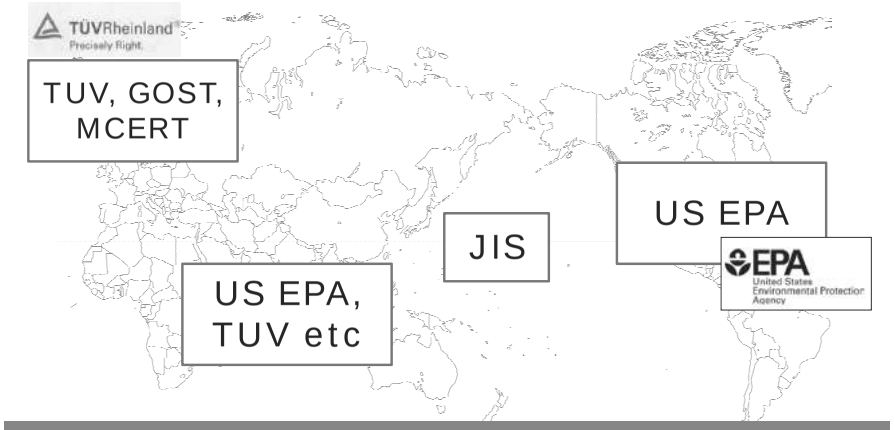
- **Selection of analyzers**
  - Chose suitable analyzer depends on monitoring purpose
- **Performance of the analyzer**
  - Standard, Compliance, Drift, Repeatability and etc.
- **Standard Operation Procedure**
  - SOP
- **Calibration of the analyzer**
  - Accuracy of standard gas
  - Periodical Zero & Span calibration
- **Maintenance & Service capability**

Utilization of Monitoring Data

Vietnam



Standards for Ambien Monitoring



Popular worldwide standard are TUV & US EPA

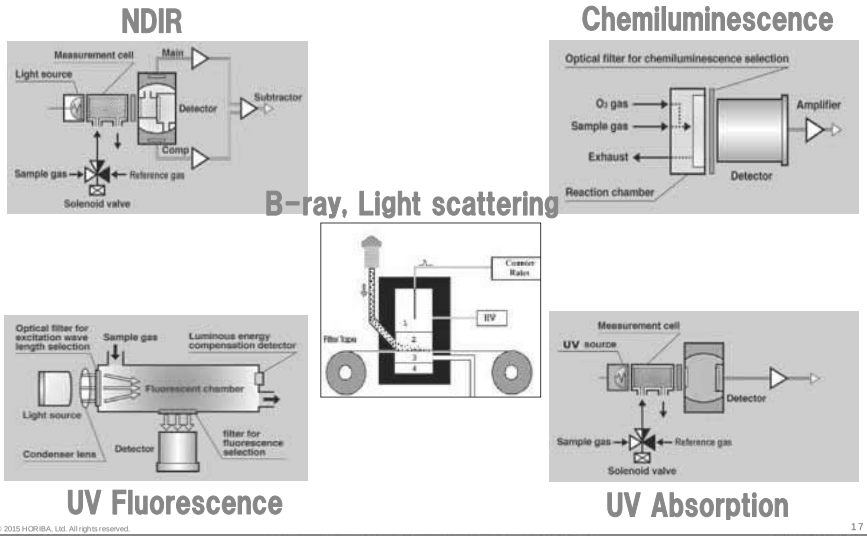
Example of impact by Air Pollutants

Pollutants	Environment & Health Impact
NOx (NO, NO2)	Acid rain, Photochemical oxidant, Effect on function of respiratory system of human. One of the cause of Oxidize smog.
SOx (SO2)	Acid rain phenomenon, Effect on forest and lakes, Effect on function of respiratory system of human
CO	Interfere with the transportation of oxygen by blood
O3	Oxidize smog, Irritation of mucosal tunics, Effect on function of respiratory system of human.
PM10, PM2.5	Effect on function of respiratory system of human

Approx. 3.3M people died caused by air pollution

According to research published on Nature

Methods for Ambient Analyzer



Methods of Ambient Analyzer

Pollutants	Model	Technology
NOx (NO, NO2)	APNA-370	CLD (Chemiluminescence)
SOx (SO2)	APSA-370	UVF (UV fluorescence)
NH3	APNA-370 +CU2	CLD (Chemiluminescence) + Catalyst method
H2S	APSA-370 +CU1	UVF (UV fluorescence) + Catalyst method
CO	APMA-370	NDIR (Non-dispersive infrared)
O3	APOA-370	NDUV (Non-dispersive Ultra - Violet)
THC	APHA-370	Selective combustion FID
PM10, PM2.5	APDA-371	Beta ray attenuation
Benzen	OEM	Gas chromatograph

Performance for Ambien Analyzer

For NOx by CLD		Performance
JIS (Japanese Industry Standard)	B 7953	Repeatability : +/-2%FS Zero Drift : +/-2%FS Span Drift : +/-2%FS Linearity : +/-4%FS LDL : Less than 1%FS and etc
US EPA	Part 53	Zero Drift : +/-0.004ppm Span Drift : +/-3.0% LDL : Less than 0.002ppm and etc
TUV	EN 14211	Repeatability standard deviation at zero : ≤ 1,0 nmol/mol and etc

+ Analyzer Range

Performance for Ambien Analyzer

Example of NOx in JIS		Range 0-0.1ppm	Range 0-5ppm	Range 0-50ppm
Repeatability	+/-2%FS	+/- 0.002ppm	+/- 0.1ppm	+/- 1ppm
Zero Drift	+/-2%FS	+/- 0.002ppm	+/- 0.1ppm	+/- 1ppm
Span Drift	+/-2%FS	+/- 0.002ppm	+/- 0.1ppm	+/- 1ppm
Linearity	+/-4%FS	+/- 0.004ppm	+/- 0.2ppm	+/- 2ppm
LDL	≦1%FS	≦ 0.001ppm	≦ 0.05ppm	≦ 0.5ppm

If performance changed?		Range 0-0.1ppm	Range 0-5ppm	Range 0-50ppm
Repeatability	+/-4%FS	+/- 0.004ppm	+/- 0.2ppm	+/- 2ppm
Zero Drift	+/-4%FS	+/- 0.004ppm	+/- 0.2ppm	+/- 2ppm
Span Drift	+/-4%FS	+/- 0.004ppm	+/- 0.2ppm	+/- 2ppm
Linearity	+/-8%FS	+/- 0.008ppm	+/- 0.4ppm	+/- 2ppm
LDL	≦2%FS	≦ 0.002ppm	≦ 0.1ppm	≦ 1ppm

- 1ppb = 0.001 ppm
- FS means " full scale " = Selected analyzer range

Zero and Span Calibration

- **Zero drift**
  - A gradual and undesired change in the zero reading or indication of a meter of instrument. This is usually corrected via a zero calibration
- **Zero calibration**
  - Set the zero value by using the standard substance which show zero. We use calibration gas for analyzer. Normally N2.
- **Span drift**
  - A gradual and undesired change in the span reading. Normally span can be defined as the range of an instrument from the minimum to maximum scale value.
- **Span calibration**
  - Set the span value by using the substance. We use calibration gas which concentration is known. Normally 90% of analyzer range. If the analyzer range is 0-0.1ppm, need 0.09ppm calibration gas

Image of zero

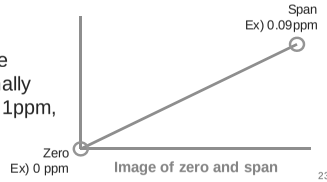


Image of zero and span

Performance for Ambien Analyzer

Example of NOx in JIS	Range 0-0.1ppm	Range 0-5ppm	Range 0-50ppm
Repeatability	+/-2%FS	+/- 0.002ppm	+/- 0.1ppm	+/- 1ppm
Zero Drift	+/-2%FS	+/- 0.002ppm	+/- 0.1ppm	+/- 1ppm
Span Drift	+/-2%FS	+/- 0.002ppm	+/- 0.1ppm	+/- 1ppm
Linearity	+/-4%FS	+/- 0.004ppm	+/- 0.2ppm	+/- 2ppm
LDL	≦1%FS	≦ 0.001ppm	≦ 0.05ppm	≦ 0.5ppm

NO_2	PM_{10}	$PM_{2.5}$	O_3	SO_2
0.1 ppm /hr mean	-	-	0.05 ppm /8hr mean	0.19 ppm /10min mean
-	50 µg/m3 /day mean	25 µg/m3 /day mean	-	0.007 µg/m3 /day mean
0.02 ppm /year mean	20 µg/m3 /year mean	10 µg/m3 /year man	-	

Site : WHO Air quality guidelines
vhttp://www.who.int/mediacentre/factsheets/fs313/en/

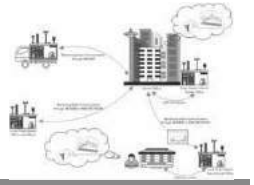
WHO Air Quality Guidelines
For NO2 : 0.1ppm / hr mean
* Calculated from 200ug/m3 based on 25 degreeC

To measure NO2 0.1ppm/hr mean, we need to have the performance which can has low range and acceptable performance.

⇒ **JIS compliance**
⇒ **US EPA, TUV certified etc**

Summary

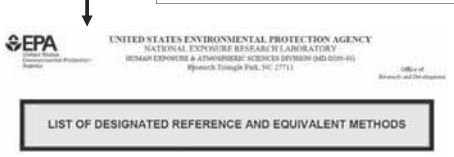
- "Monitoring" was very important to recover pollution problem in Japan too
- There are several analyzers to help monitoring
- The keys to use analyzers are
  - Selection of analyzer depending on purpose
  - Performance of analyzer
  - Standard operation procedure
  - Periodic calibration of analyzer
  - Maintenance & Service



Keep "Monitoring" continuously is Key for the success

Performance for Ambien Analyzer

⇒US EPA, TUV certified etc



NO_2 List of Designated Reference and Equivalent Methods, December 18, 2015 Page 43

Horiba Instruments Model APNA-370 NO_2 Monitor
Automated Reference Method: RFNA-0506-157
"Horiba Instruments Incorporated Model APNA-370 Ambient NO_2 Monitor," standard specification, operated with a full scale fixed measurement range of 0 - 0.50 ppm with the automatic range switching off, at any ambient temperature in the range of 20°C to 30°C, and with a 0.3 micrometer sample particulate filter installed.[2]
Federal Register: Vol. 71, page 25587, 05/01/2006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Thank you
Omoshiro-okashiku
Joy and Fun
감사합니다
Cảm ơn
ありがとうございました
Dziękuję
धन्यवाद
Grazie
Merci
谢谢
நன்ற
ขอบคุณครับ
Obrigado
Σας ευχαριστούμε
اشكْر
Tack ska ni ha
ស្ងួមអរគុណ។
Danke
Большое спасибо
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25
Explore the future
HORIBA

Law, Rules and Regulations

- Motor Vehicle Law
- Motor Vehicle Rules
- 1993 Tester Manual
- Order and Regulations
- Asean Standard (Motor Vehicle Safety Requirement Standard)
- Timely Instructions

About Motor Vehicle Law

- The New Motor Vehicle Law was enacted in September , 2015
- The issue to reduce the environmental impacts by motor vehicles is one of the objectives of the Motor Vehicle Law
- Emission standards and regulations have to be enacted in the motor vehicle rule

MINISTRY OF RAIL TRANSPORTATION

ROAD TRANSPORT ADMINISTRATION DEPARTMENT

Vehicle Emission Control By RTAD

25.2.2016 UMFCCI, Yangon

OBJECTIVES AND RESPONSIBILITIES OF RTAD

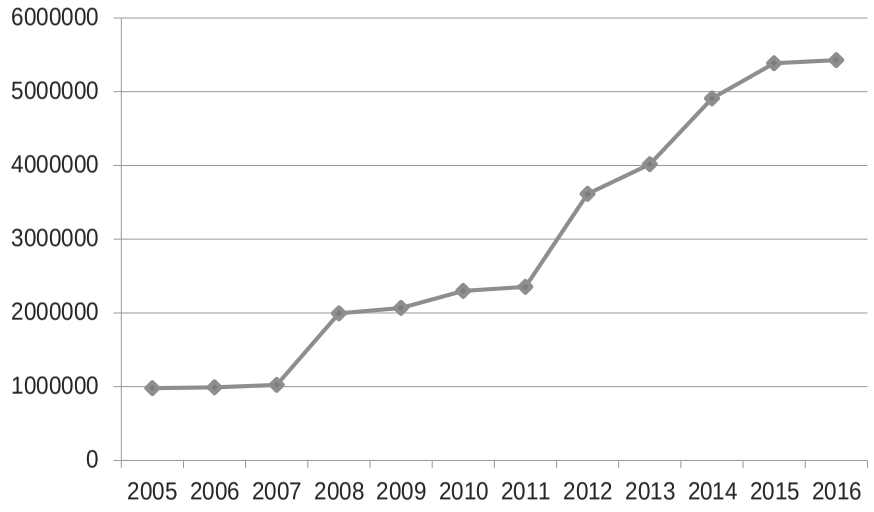
ROAD SAFETY

- Vehicle inspection and registration in accordance with laws and rules
- Testing the drivers and issuing driving licenses in accordance with laws and rules
- Issuing road safety measures for road users
- Levying vehicles-related fees for the state in accordance with laws and rules
- To reduce environmental damages impacted by the usage of vehicles

Motorization

Since September 2011, the government has begun to relax the importation policies of vehicles to promote replacement of over 20 years old manufactured motor vehicles. Vehicle population in Yangon urban area has been increasing day by day. Rapid expansion of motorization results to worsening traffic congestion in Yangon urban area

Motor Vehicle Trend of Myanmar (from 2005 to January-2016)



Total Registered Vehicles by Types as of January 2016

Sr.	Types	The whole country	In Yangon Region	% in Yangon
1.	Passenger car	452697	320056	70.7
2.	Bus	25584	15368	60.1
3.	Truck (light)	178365	123207	69.1
4.	Truck (heavy)	64786	17846	27.5
5	Others (Special Utility Vehicles)	51356	30365	59.1
6	Two-wheelers	4536570	228748	5.0
7	Three-wheelers	73611	3740	5.1
8	Trawlergi (Farm truck)	43605	2858	6.5
9	Machinery	1376	524	38.0
10	Total	5427950	742712	13.6

Total Registered Vehicles by Types and Fuel as of January 2016

Sr.	Types	Fuel					
		Gasoline	Diesel	CNG	LPG	EV	HV
1.	Passenger car	341110	109155	2258	11	69	94
2.	Bus	1605	18053	5921	5	-	-
3.	Truck (light)	62894	113253	2140	77	1	-
4.	Truck (heavy)	1287	62082	1373	44	-	-
5	Others (Special Utility Vehicles)	2189	48705	460	2	-	-
6	Two-wheelers	4533019	-	-	-	3551	-
7	Three-wheelers	72969	219	14	-	409	-
8	Trawlergi (Farm truck)	34	43571	-	-	-	-
9	Machinery	1	1374	1	-	-	-
10	Total	5015108	396412	12167	139	4030	94

Complete Vehicle Inspection Test Lanes

- Nay Pyi Taw
- Yangon(Ywar-Tha-Gyi)
- Mandalay
- Mawlamyaing

Emission Test Stations in Myanmar

- Nay Pyi Taw
- Yangon Regional Office
- Yangon West District
- Yangon East District
- Yangon North District
- Yangon South District
- Mandalay South District
- Sagaing Regional Office (Monywa)
- Ayeyarwaddy Regional Office (Pathein)
- Bago Regional Office (Bago)
- Magway Regional Office (Magway)
- Meikhtila District
- Pyay Disttrict
- Sagaing District
- Myingyan District

MOTOR VEHICLE SAFETY REQUIREMENT STANDARD AS AGREED BY ASEAN COUNTRIES

No	SUB SUBJECT	STANDARD	REMARKS
1	**Brake Minimum Efficiency &** **a. Service Brake** Passenger Cargo Car & Bus 1. GVW < 3500 kg 2. GVW > 3500 kg **b. Parking Brake** 1. Rigid Vehicle 2. Trailer Combination	 60 % 50 % 16 % (up grade of down grade) 12% (up grade of down grade)	

MOTOR VEHICLE REQUIREMENT STANDARDS AS AGREED BY ASEAN COUNTRIES

No	SUB SUBJECT	STANDARD	REMARKS
2	Side Slip (m / km)	-5 to +5	
3	**Overall Noise Max db (A)**	**115**	
4	**Horn db(A)**	**90**	
5	Main Lamp Min (cd) Light alignment	12000 Up < 0 Down :< 2 / 100 Left :< 2 / 100 Right :< 2 / 100 R Lamp :< 1 / 100 L Lamp	
6	Min turning radius, Max (m)	12 m	
7	Elevation of Speedometer (%)	-10 to +15	
8	**Exhaust Emission(Smoke)**	**50% < Bosch Unit**	
9	Depth of groove of Tyre [Min: (mm)]	1 mm	

Gasoline; 4 gas analyzer test in District office (South Dagon)

Inspection with Mobile Test Lane in Mandalay

Exhaust Emission Tester

Diesel; Smoke test in Yangon Sub-Regional Office (Ywarthagyi)

On-going Environmental Actions in the Transport Sector

BY

Road Transport
Administration Department

Sr	Actions	Respon-sible Bodies	Objective
1.	End-of-life vehicles Replacing program (including auction vehicle)	-Ministry of Commerce -RTAD	-To mitigate pollution caused by the old vehicle -To promote the standards of the car
2	Installing the modernized vehicles inspection lanes	-RTAD	-To promote the vehicles' road worthiness -To promote road safety and emission testing on each car to meet their limits
3	Permission to private sector or Public Private Partnership in vehicle inspection	-RTAD -Private sector	-To promote the vehicles' road worthiness -To promote road safety and emission testing on each car to meet their limits -To inspect all vehicles
4	Using CNG and Natural gas for vehicles	-MOGE -RTAD -MOT	-To reduce air pollutants caused by fossil fuel used vehicles

Noise Tester

Pit Inspection

Importing Vehicles by Model Year Substitution Old Vehicle Program (2016)

- Passenger Car — Model 2006 to 2010
- Passenger Vehicle < 1350 cc — Model 2006 to 2016
- Trucks — Model 2006 to 2010
- Bus and City Bus — Model 2006 to 2010

End-of-Life Vehicles Replacing Program

	End of Life Vehicles	Permission to New Vehicles	Initial Registration of Replacing Vehicles
From 19.9.2011 to 8.2.2016	204436	202845	191825

Establishment of National Road Safety Council (NRSC)

- Established on 24th June 2014
- To implement National Road Safety Action Plan
- Chairman of Steering Committee => Vice President
- Membership => 40 persons
- Under the umbrella of NRSC, local authority of every State and Region sets up their respective Road Safety Council (RSC).

Responsibility of NRSC Concern with Environment

- To reduce environmental damages impacted by the usage of vehicles;

Cooperation with Private Sector

Purpose - To match rapid motorization of Myanmar

- Road Safety and Road Worthiness

On-going Procedures

13.9.14 & 9.10.14 - Invitation for EOI (Expression of Interest)

(29) companies proposed EOI

9.10.2014 - RTAD created "Private Sector Development Committee" and haired a professional lawyer to complete this task

5.2.15 - Coordinating meeting was held in Nay Pyi Taw among RTAD and these 29 companies

7.9.15 - New Motor Vehicle Law was released and in which the provision for Private Sector Vehicle Inspection was included. The details for this matter will be enacted in modified Motor Vehicle Rules.

Daily Urban Transportation Modes

Bus users – 63.7%

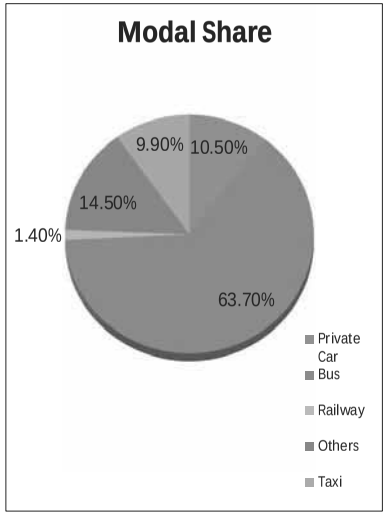
Taxi users 9.9%

Railway users – 1.4%

Others 14.5%

Public Car users – 10.5%

Usage of Motorcycle is prohibited in Yangon urban area



Source: JICA

Challenges in Vehicle Emission Control

- Emission standards (new production vehicles, new registered and in used vehicles)
- Method of their test procedures
- Technical knowhow of testing equipments and testing facilities
- Insufficient Emission testers for all types of vehicles
- Lack of road side inspection with emission testers
- Lack of public awareness for periodically technical inspection
- Reliable public transport
- To reduce street cars in urban area

Way Forward

- To mitigate emission caused by road transport, the followings should be considered as our way forwards;
  1. To inspect all vehicles with modernized vehicle test lane
  2. To reduce street cars on road in urban areas
  3. To promote public transportation in major cities

Current Problems and Issues of Bus Transport

Bus service is the prime mode of transport for people's mobility in Yangon
High modal share (63.7%)

- Low level of service
- Poor conditions of bus stop shelters, seating facilities
- Lack of provisions of bus information
- Overlapping of bus routes
- On-road competition among operators

Long waiting time, crowded on board, uncomfortable, unreliable and unsafe travel is resulted

Urban Transport Development Strategies

➢ **To promote modal share of Urban Mass-Transit System**
- Current modal share 1.4%

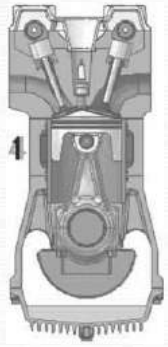
➢ **To maintain modal share of Public Bus Transport**
- Current modal share 63.7%
- Bus network restructuring
- Modernization of bus services
- Bus priority measure improvement
- BRT system
- PPP on bus transport
- Introduction of ITS

Vehicles and Engine

Gasoline vehicle

Diesel vehicle

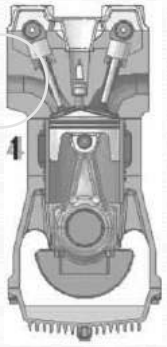
Vehicle engine



1. Intake
2. Compression
3. Combustion
4. Exhaust

Vehicles and Engine

Exhaust gases are generated from the combustion process



1. Intake
2. Compression
3. Combustion
4. Exhaust

Seminar on Myanmar-Japan, Co-benefits approach bilateral cooperation project

Vehicle exhaust gas session

2) Vehicle exhaust gas abatement measure

Japan Automobile Research Institute (JARI)
Akiyoshi ITO

25th February, 2016

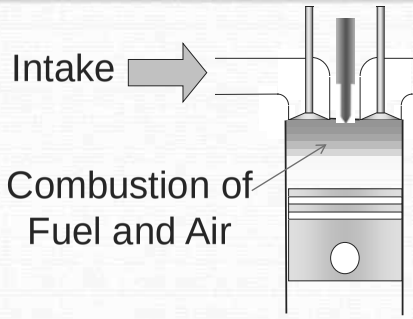
Contents

To avoid becoming these situations...

Vehicle Emission Control is very IMPORTANT

Contents

Exhaust emissions from engine combustion



Main components:
- Carbon Dioxide (CO_2)
- Water Vapor (H_2O)
- Nitrogen (N_2)

Other important gases:

	Typical Health Effects
Carbon Monoxide (CO)	Carbon monoxide poisoning
Hydrocarbons (HC)	Nervous disease
Nitrogen Oxides (NOx)	Respiratory disease
Particulate Matter (PM)	Cancer

Exhaust emissions from fuel

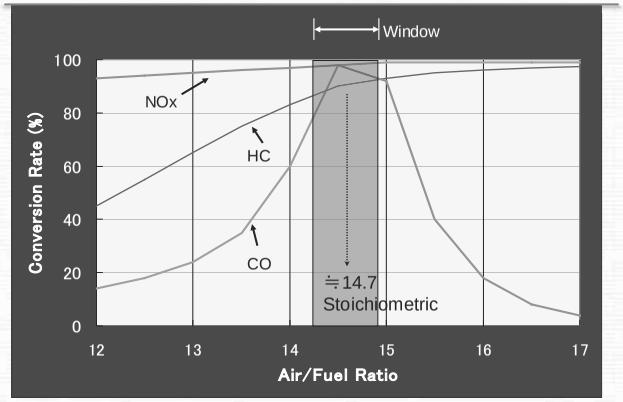
Fuel

	Typical bad effect
Benzene	Respiratory disease, Cancer, Nervous disease
Lead (Pb)	Nervous disease, Digestive disease, Catalyst Poisoning (Increasing of CO,THC,NOx)
Sulfur	Catalyst Poisoning (Increasing of CO,THC,NOx), Shorter engine life
Aromatics	Increasing of PM and NOx

Supplemental

Conversion rate of three-way catalyst

11



<-Rich Lean->

NOx -> decrease

CO, HC -> decrease

Characteristics of exhaust gas from diesel engine

12

Diesel vehicle exhaust:
contains much oxygen(O_2)
-> Three-way catalyst is NOT applicable.

Emissions reduction technologies
PM: Diesel Particulate Filter (DPF)
Common Rail
NOx: NOx storage catalyst
SCR system
Exhaust Gas Recirculation (EGR)
CO, HC: Oxidation Catalyst

Characteristics of exhaust gas from gasoline engine

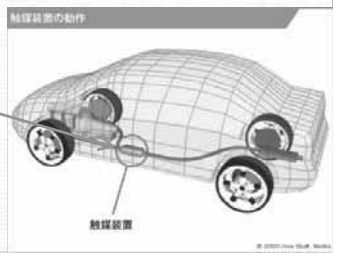
9

Gasoline vehicle exhaust:
Carbon monoxide (CO)
Hydrocarbons (HC)
Nitrogen Oxides(NOx)

Particulate Matter (PM) emissions are very low because of premixed combustion.

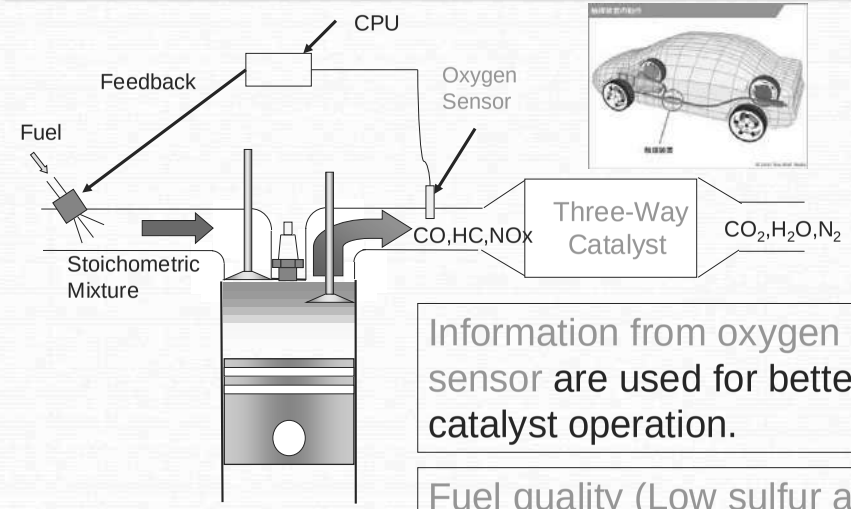
Emissions reduction technology
Three-way catalyst

CO, HC and NOx decrease simultaneously.



Three-Way Catalyst

10

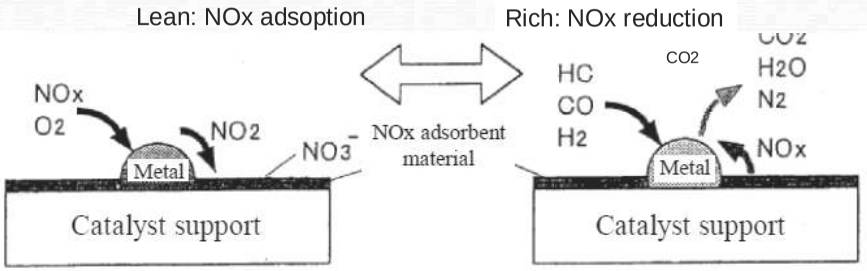


Information from oxygen sensor are used for better catalyst operation.

Fuel quality (Low sulfur and unleaded) are essential for better catalyst operation.

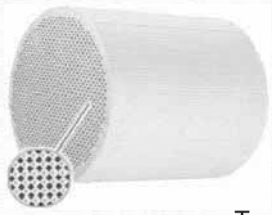
Supplemental

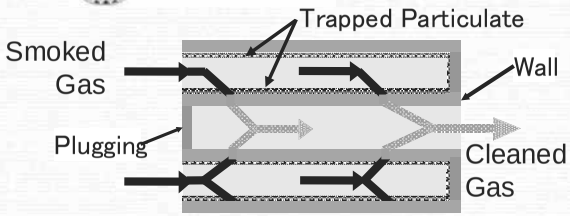
NOx Reduction:
NOx Storage Catalyst



Supplemental

PM Reduction:
Diesel particulate filter (DPF)

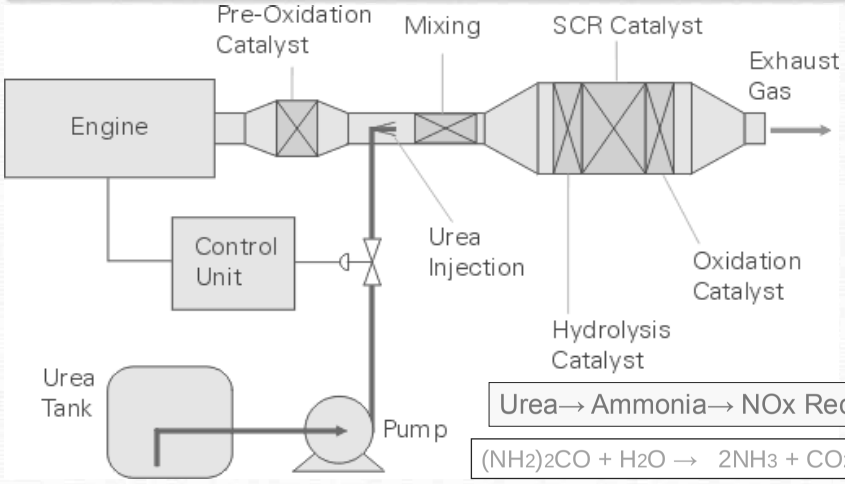




Particulate matter is trapped by ceramic filter.

Supplemental

NOx Reduction:
Urea SCR System



Urea→ Ammonia→ NOx Reduction

$(NH_2)_2CO + H_2O \rightarrow 2NH_3 + CO_2$

$4\ NH_3 + 4\ NO + O_2 \rightarrow 4\ N_2 + 6\ H_2O$

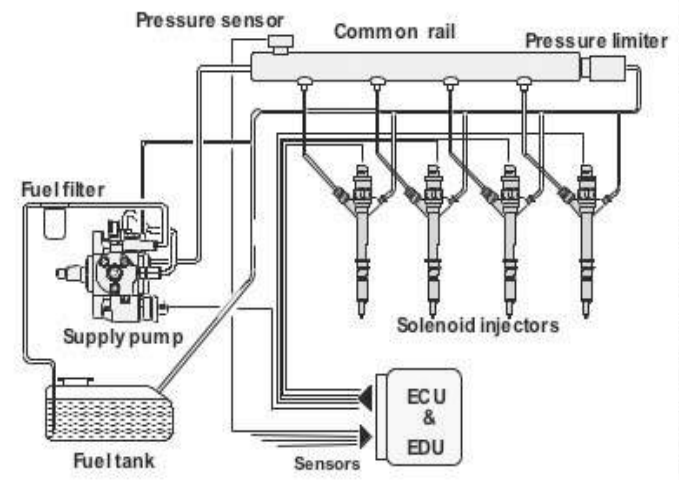
$4\ NH_3 + 2\ NO + 2\ NO_2 \rightarrow 4\ N_2 + 6\ H_2O$

$8\ NH_3 + 6\ NO_2 \rightarrow 7\ N_2 + 12\ H_2O$

SCR: Selective Catalytic Reduction

Supplemental

PM Reduction:
Common Rail System



PM emissions are reduced by precise combustion control.

Abatement measures of the air pollution from vehicles

Improvement of the Fuel Quality:
- from Leaded gasoline to Unleaded gasoline
- from High sulfur fuel to Low sulfur fuel

Repair and Maintenance of the vehicles:
- replacement of the catalyst
- automobile inspection

Replacement from old car to low emission car:
- ex) Hybrid Engine Vehicle.

Traffic Control to avoid the traffic congestion:

Which measures are more effective for Myanmer?

Summary

1. Vehicle emission control is very important for your health and environment

2. Various emission abatement technologies are applied for gasoline and diesel engine.

3. Abatement measures of the air pollution from vehicles are:
- Fuel quality improvement
- From old car to low emission car
- Repair and maintenance
- Traffic control

It is important to choose better abatement measure. For this, understanding the current air pollution from vehicles and specific emission sources are essential.

Contents

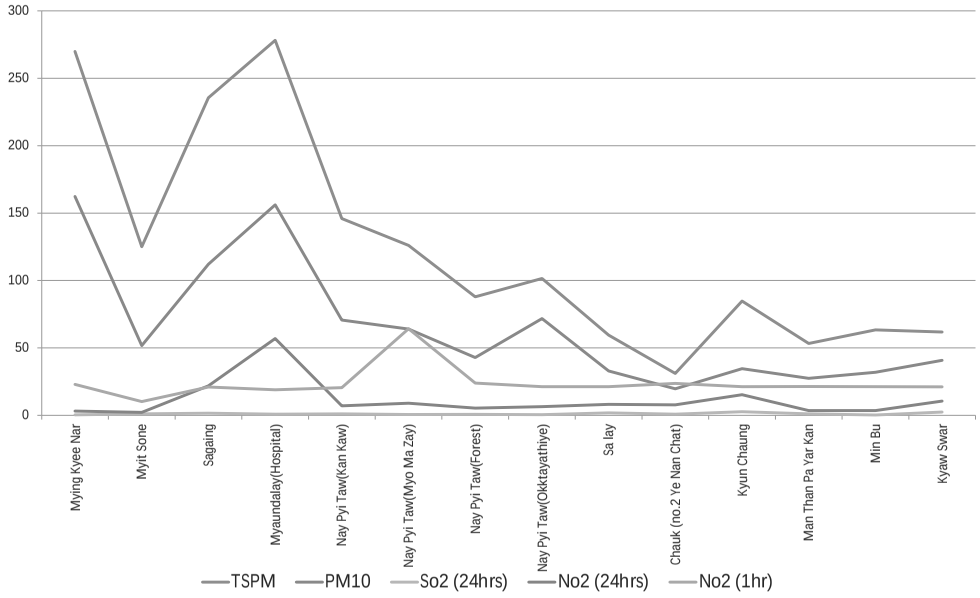
Factors to worsen the air pollution from vehicles

Failure of the catalyst and/or aftertreatment devices
- physically broken
- poisoning by Sulfur and Lead (Pb)

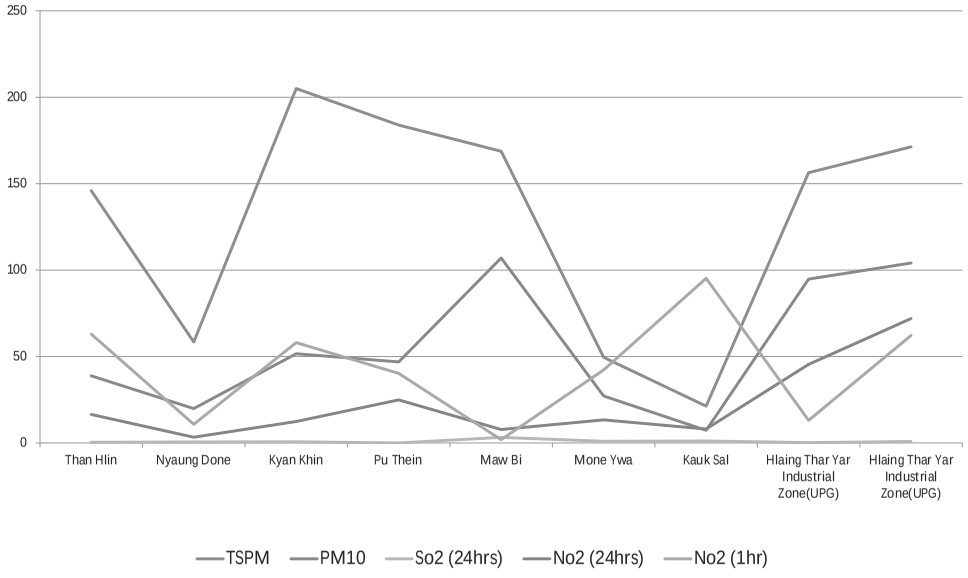
Poor maintenance of the vehicles
- physically broken
- inadequate control due to the troubles of sensors

Air pollution by
Heavy Traffic Congestion

2009



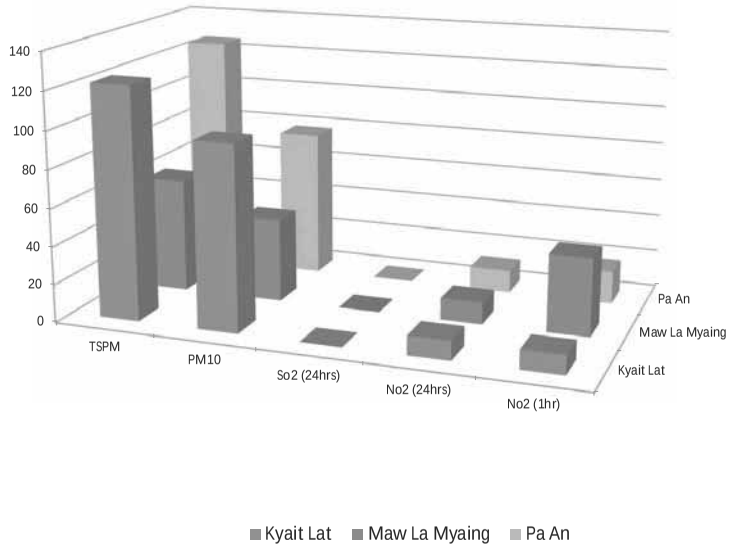
2010

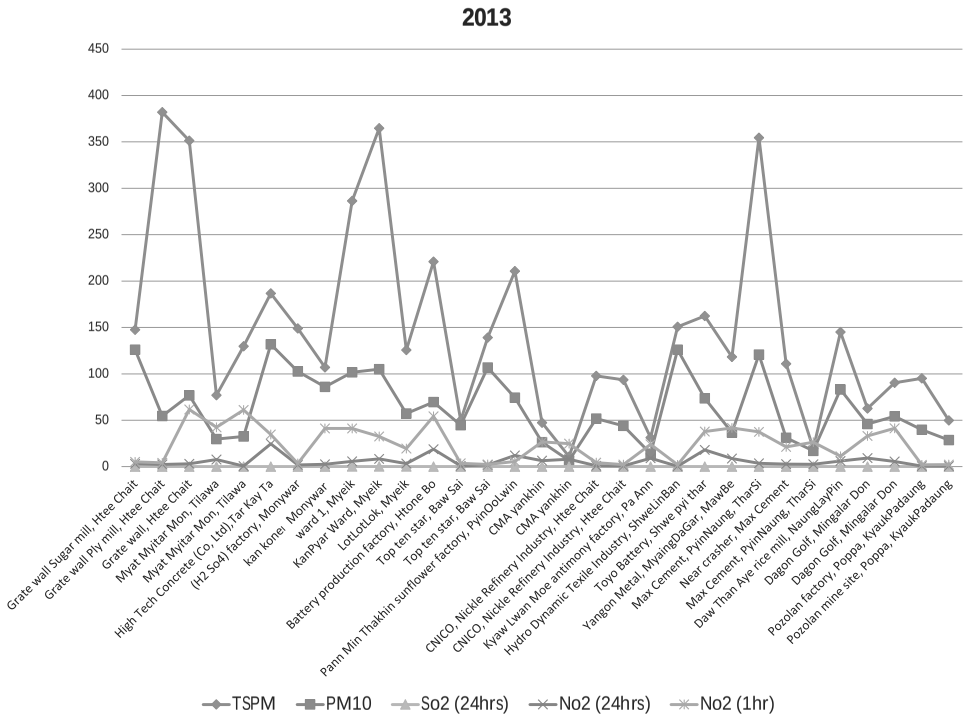


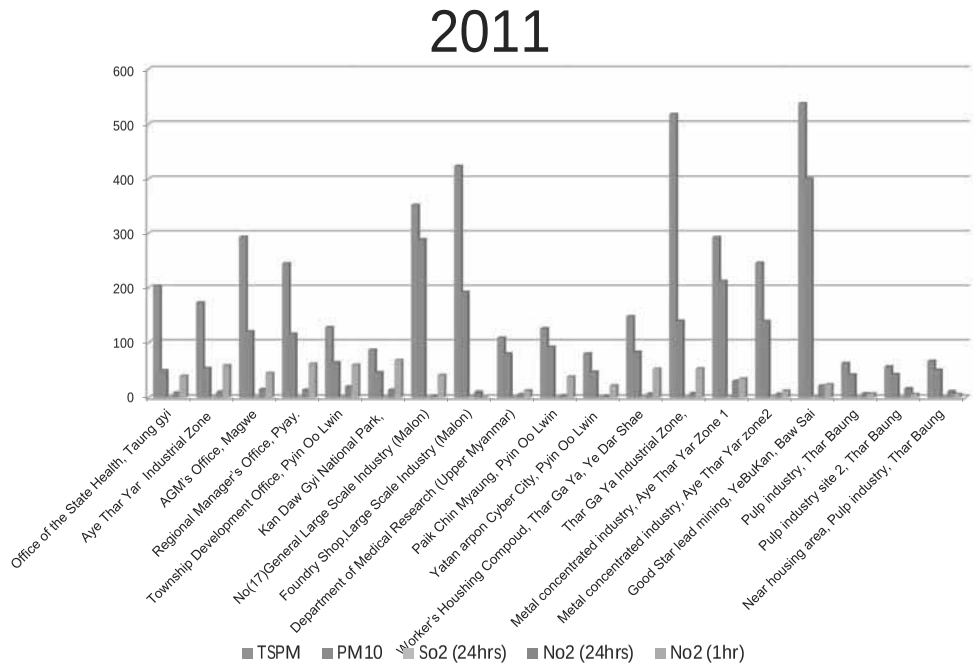
Air Quality and Workers' Health

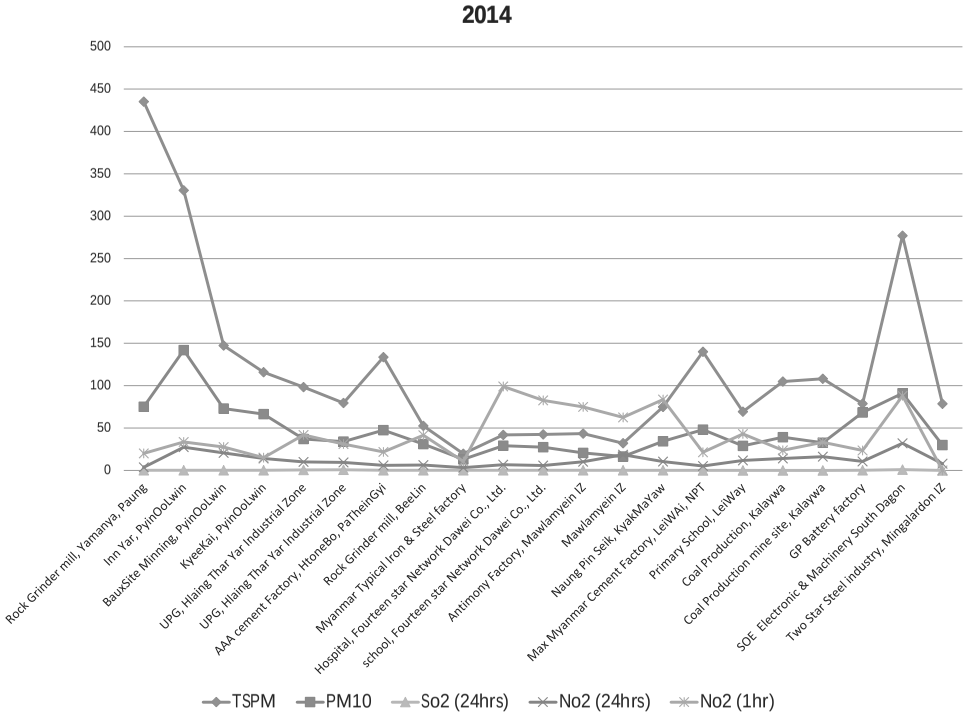
Dr. Kyi Lwin Oo
Director
Occupational and Environmental Health
Department of Public Health

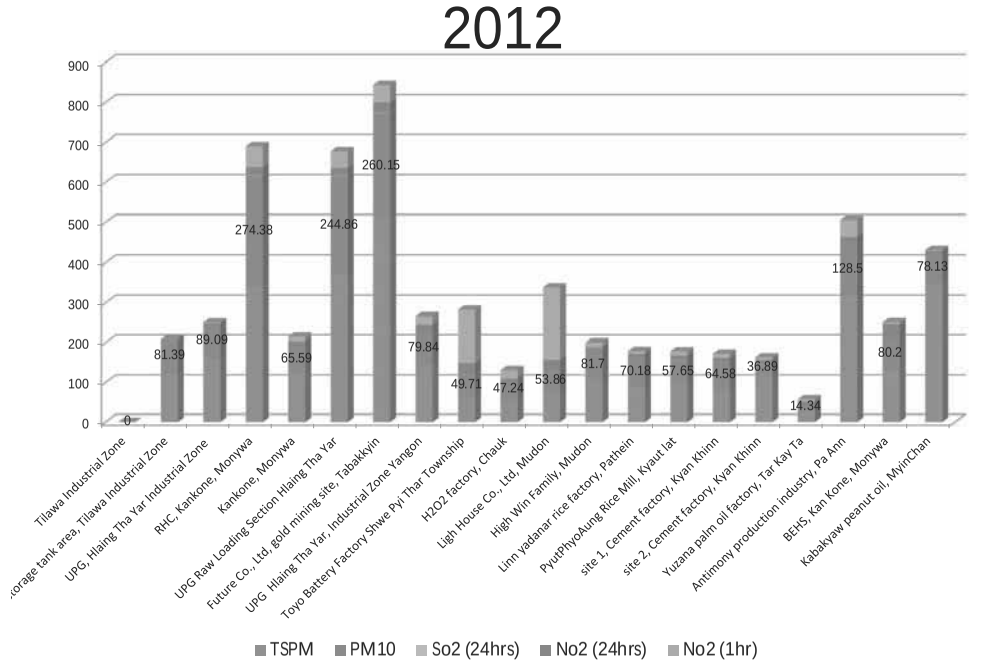
2008




2013
450
400
350
300
250
200
150
100
50
0
Grate wall Sugar mill, Htee Chait
Grate wall Ply mill, Htee Chait
Grate wall, Htee Chait
Myat Myitar Mon, Tilawa
Myat Myitar Mon, Tilawa
High Tech Concrete (Co, Ltd)Tar Kay Ta
(H2 SoA) factory, Monywar
kan Kone, Monywar
ward 1, Myeik
KanPyar Ward, Myeik
LotLotLok, Myeik
Battery production factory, Htone Bo
Top ten star, Baw Sai
Top ten star, Baw Sai
Pann Min Thakhin sunflower factory, PyinOoLwin
CMA yankhin
CMA yankhin
CNICO, Nickle Refinery Industry, Htee Chait
CNICO, Nickle Refinery Industry, Htee Chait
Kyaw Lwan Moe antimony factory, Pa Ann
Hydro Dynamic Textile Industry, ShweLinBan
Toyo Battery, Shwe pyi thar
Yangon Metal, MyaingDaGar, MawBe
Max Cement, PyinNaung, TharSi
Near crasher, Max Cement
Max Cement, PyinNaung, TharSi
Daw Than Aye rice mill, NaungLayPin
Dagon Golf, Mingalar Don
Dagon Golf, Mingalar Don
Pozolan factory, Poppa, KyaukPadaung
Pozolan mine site, Poppa, KyaukPadaung
TSPM
PM10
So2 (24hrs)
No2 (24hrs)
No2 (1hr)

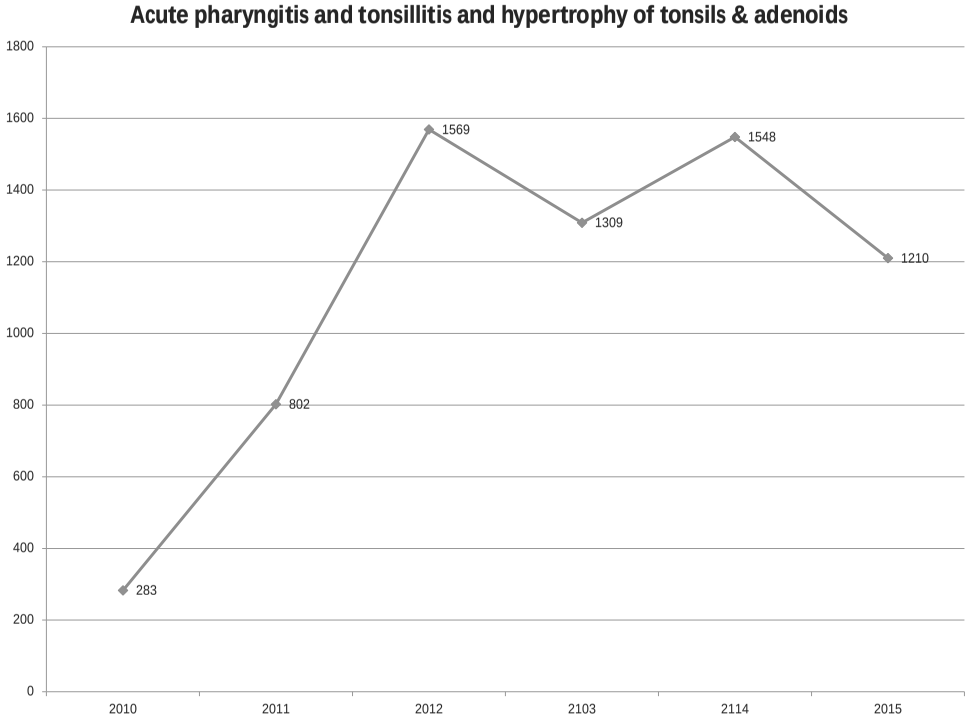

2011
600
500
400
300
200
100
0
Office of the State Health, Taung gyi
Aye Thar Yar Industrial Zone
AGM's Office, Magwe
Regional Manager's Office, Pyay,
Township Development Office, Pyin Oo Lwin
Kan Daw Gyi National Park,
No(17)General Large Scale Industry (Malon)
Foundry Shop,Large Scale Industry (Malon)
Department of Medical Research (Upper Myanmar)
Palk Chin Myaung, Pyin Oo Lwin
Yatan arpon Cyber City, Pyin Oo Lwin
Thar Ga Ya, Ye Dar Shae
Thar Ga Ya Industrial Zone,
Worker's Houshing Compoud, Thar Ga Ya Industrial Zone 1
Metal concentrated industry, Aye Thar Yar zone2
Metal concentrated industry, Aye Thar Yar Zone 1
Good Star lead mining, YeBuKan, Baw Sai
Pulp industry, Thar Baung
Pulp industry site 2, Thar Baung
Near housing area, Pulp industry, Thar Baung
TSPM
PM10
So2 (24hrs)
No2 (24hrs)
No2 (1hr)


2014
500
450
400
350
300
250
200
150
100
50
0
Rock Grinder mill, Yamanya Paung
Inn Yar, PyinOoLwin
BauxSite Minning, PyinOoLwin
KyeeKai, PyinOoLwin
UPG, Hlaing Thar Yar Industrial Zone
UPG, Hlaing Thar Yar Industrial Zone
AAA cement Factory, HtoneBo, PaTheinGyi
Rock Grinder mill, BeeLin
Myanmar Typical Iron & Steel factory
Hospital, Fourteen star Network Dawei Co., Ltd.
school, Fourteen star Network Dawei Co., Ltd.
Antimony Factory, Mawlamyein IZ
Mawlamyein IZ
Naung Pin Seik, KyaikMaYaw
Max Myanmar Cement Factory, LeiWAI, NPT
Primary School, LeiWay
Coal Production, Kalaywa
Coal Production mine site, Kalaywa
GP Battery factory
SOE Electronic & Machinery South Dagon
Two Star Steel industry, Mingalardon IZ
TSPM
PM10
So2 (24hrs)
No2 (24hrs)
No2 (1hr)


2012
900
800
700
600
500
400
300
200
100
0
0
81.39
89.09
274.38
65.59
244.86
260.15
79.84
49.71
47.24
53.86
81.7
70.18
57.65
64.58
36.89
14.34
128.5
80.2
78.13
Tilawa Industrial Zone
Storage tank area , Tilawa Industrial Zone
UPG, Hlaing Tha Yar Industrial Zone
RHC, Kankone, Monywa
Kankone, Monywa
UPG Raw Loading Section Hlaing Tha Yar
Future Co., Ltd, gold mining site, Tabakkyin
UPG, Hlaing Tha Yar, Industrial Zone Yangon
Toyo Battery Factory Shwe Pyi Thar Township
H2O2 factory, Chauk
Ligh House Co., Ltd, Mudon
High Win Family, Mudon
Linn yadanar rice factory, Pathein
PyutPhyoAung Rice Mill, Kyaut lat
site 1, Cement factory, Kyan Khinn
site 2, Cement factory, Kyan Khinn
Yuzana palm oil factory, Tar Kay Ta
Antimony production industry, Pa Ann
BEHS, Kan Kone, Monywa
Kabakyaw peanut oil, MyinChan
TSPM
PM10
So2 (24hrs)
No2 (24hrs)
No2 (1hr)

Reported Industries

Reported Industries			
2011	2012	2013	2014
65	59	73	73



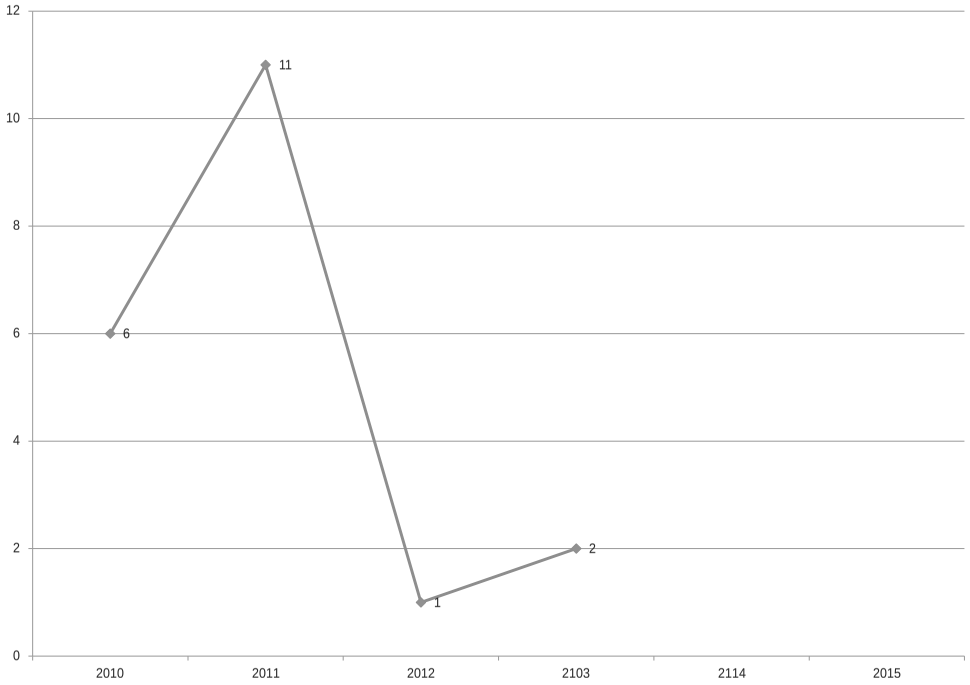
Diseases caused by Industries' Indoor Air Pollution in Myanmar

No.	Diseases	2010	2011	2012	2103	2114	2015
1.	Acute pharyngitis and tonsillitis and hypertrophy of tonsils & adenoids	283	802	1569	1309	1548	1210
2.	Bronchitis.	1049	1873	1721	1712	2331	2258
3.	All other respiratory diseases.	561	2374	2053	1988	3891	1883
4.	Diseases of ear & mastoid process.	80	261	492	370	598	455
5.	Silicosis and occupational pulmonary fibrosis.	6	11	1	2		
6.	Chronic obstructive pulmonary diseases	1610	4247	3774	3700	6222	4141

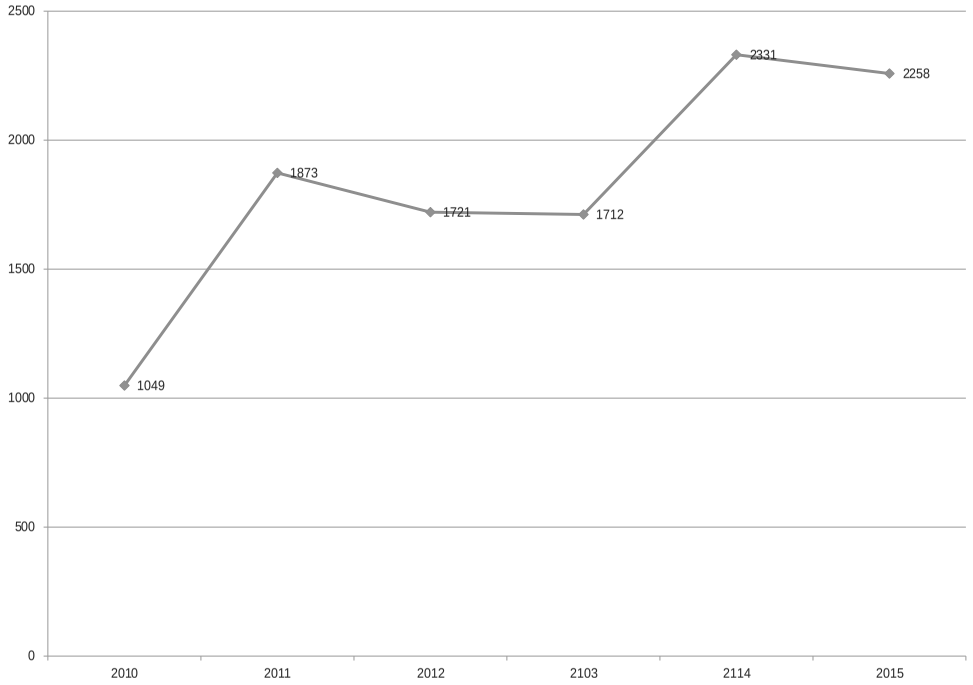
Number of Industries in Myanmar (2014)

Types of industries	Small	Medium	Large	Total
Government industries				220
Private industries	30307	8315	5656	44278
Total industries				44498

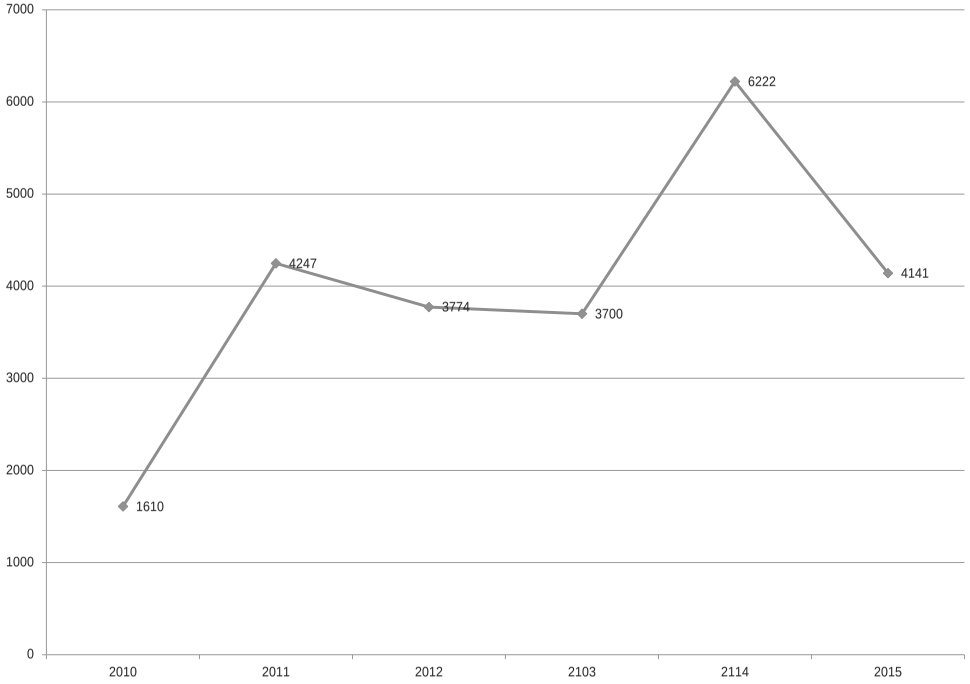
Silicosis and occupational pulmonary fibrosis.



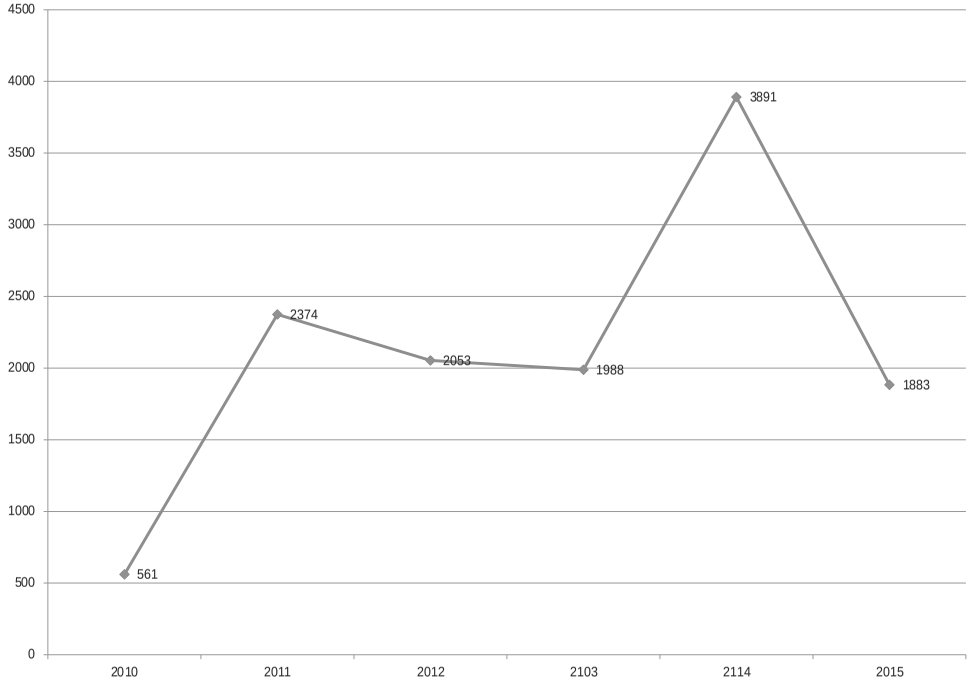
Bronchitis.



Chronic obstructive pulmonary diseases



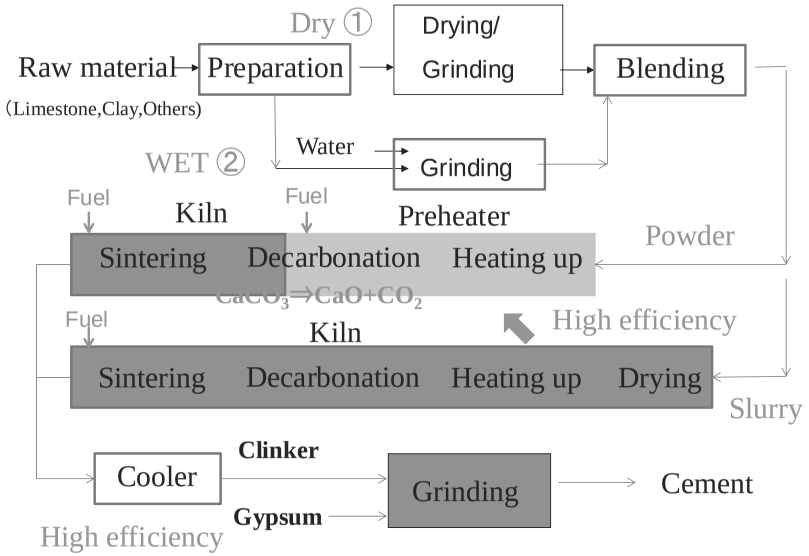
All other respiratory diseases.



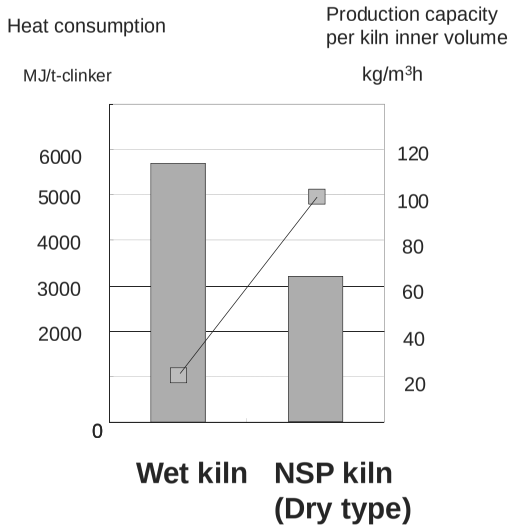
Dr. Kyi Lwin Oo

THANK YOU

Principle of cement manufacturing



Difference of heat consumption and production capacity between a wet kiln and a dry kiln.



Cement industry in Myanmar

and

Explanation of cement process

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Cement Factories in Myanmar

Company name	Plant name	Capacity		Type	Location	Province
		1000tpa	%			
Myanmar Cement Industries	Kyangin	480	13.5	Wet	Kyangin	Rakhaing
	Tha-Yet	330	9.3	Wet	Tha-Yet	Rakhaing
	Kyaukse	150	4.2	Dry	Kyaukse	Mandaley
Myanmar Economic	Tamadaw-1	240	6.7	Dry	Myaingale	Kayin
	Tamadaw-2	1200	33.6	Dry	Myaingale	Kayin
Myanmar Economic	Sinmin-1	120	3.4	Wet	Kyaukse	Mandaley
	Sinmin-2	210	5.9	Dry	Kyaukse	Mandaley
NayPyiTaw Cement		150	4.2	Wet	NayPyiTaw	
Yangon City Development Cement		150	4.2	Wet	PyinNyaung	
(Private)						
Max Cement		150	4.2	Wet	NayPyiTaw	
Myanmar Hsin	Elephant	135	3.8	Dry	Tha-Yet	Mandaley
AAA		168	4.7	Wet	Mandaley	Mandaley
Kyar Kaung	Tiger head	72	2.0	Wet	Mandaley	Mandaley
Mau Keiniyi		12	0.3	Dry	Lasio	Kachin
Total		3567	100.0			

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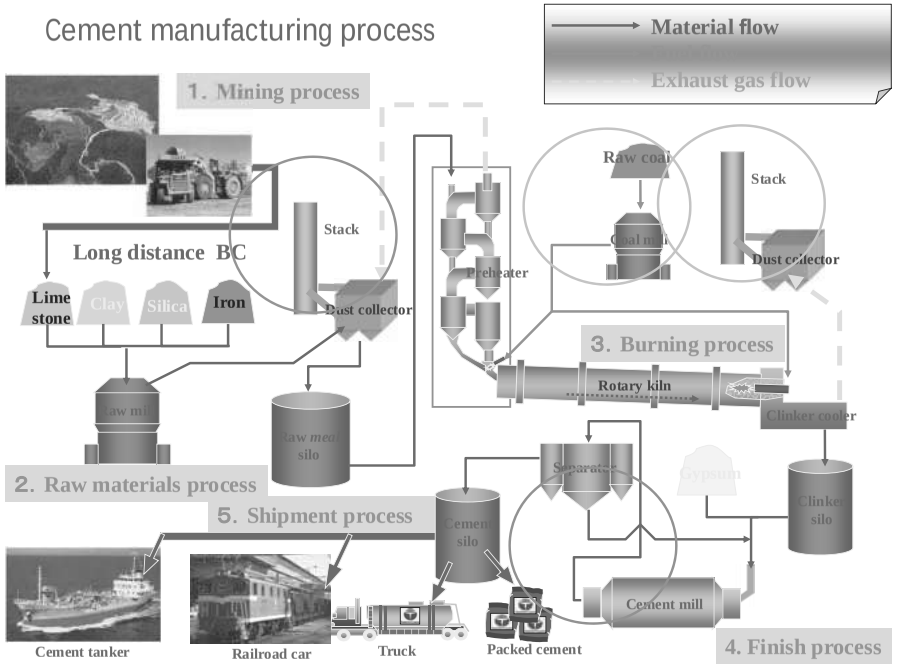
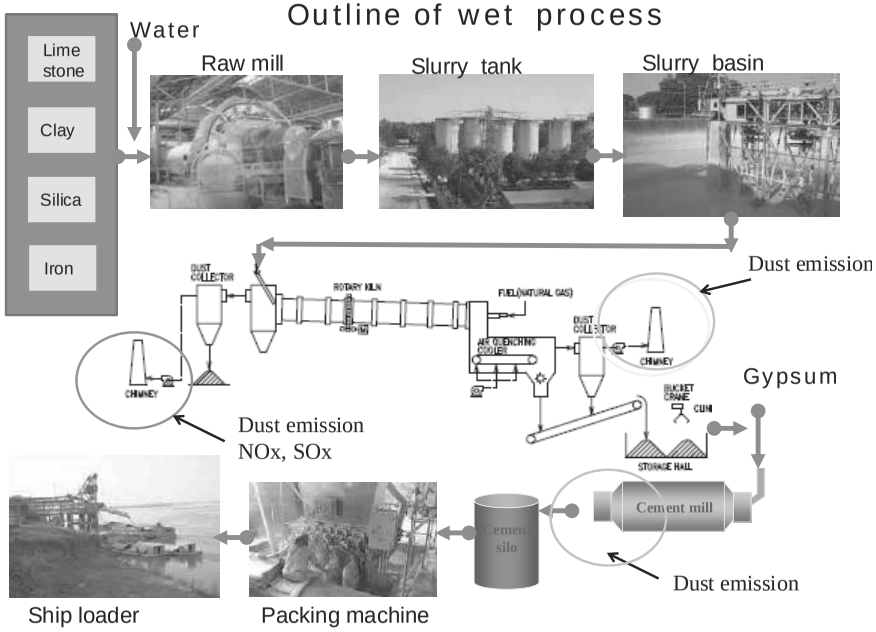
Cement Plant （NSP kiln）

Cement manufacturing process



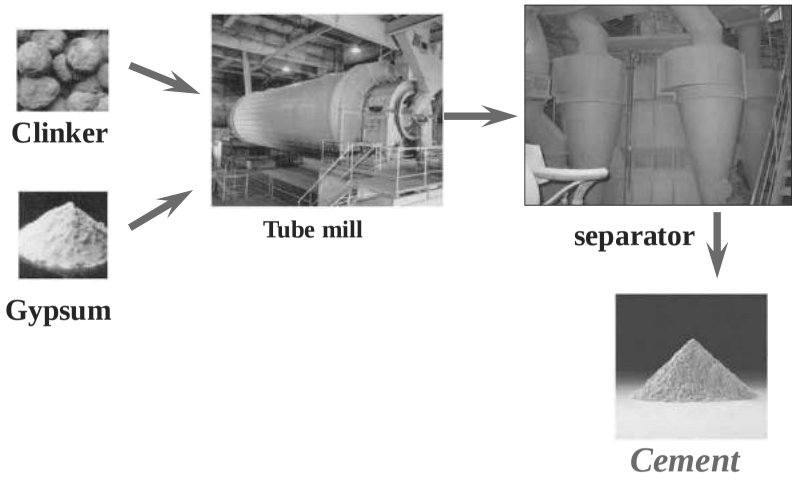
Outline of wet process



Expected Result of Application of Technology

		Content	Energy Saving	CO_2 reduction
Adoption of Dry Process	Case-1	・1,500t/d NSP Kiln +Vertical Roller Mill	456,725GCal/y + 4,022MW/y	108,502t/y
	Case-2	・1,000t/d NSP Kiln+ Vertical Roller Mill ・Operate with Wet	335,088GCal/y + 3,002MW/y	79,621t/y
Finish grinding section		・Pre-Grinder+ High Efficiency Separator	2,692MW/y	835t/y
Alternative Fuel (Biomass)	Case-1	・Rice husk to Existing Wet Process	93,778GCal/y	22,022t/y
	Case-2	・Rice husk & Straw to 1500t/d NSP Process	96,132GCal/y	22,575t/y
	Case-3	・Rice husk & Straw to 1000t/d NSP Process ・Rice husk to Existing Wet Process	97,701GCal/y	22,944t/y

Finish process



Countermeasures for the air pollution and energy-saving in the industrial section (Cement plant)

< Contents >

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Burning process-1

NSP Kiln

Inside of a kiln (Clinker temperature is around 1450℃)

Burning process-2

Clinker burnt in a kiln is cooled quickly in a cooler

Hot clinker like molten lava enters a clinker cooler and is cooled quickly .

Clinker is agglomerated in a kiln and its size becomes from 3mm to 4mm.

1. Air pollution

1-2) Regulation and daily management of NOx in Japan

＜NOx Regulation in Japan＞

A cement plant generally concluded agreement on pollution prevention with a local government. Therefore, the cement plant shall be operated less than national regulation as follows.

- 480 ppm (O_2=10%) Cement plant installed before 9/DEC/1975
- 250 ppm (O_2=10%) Cement plant installed after 10/DEC/1975

＜Daily management＞

- Implementation of ISO14001・Appointment of pollution control manager
- Continuous monitoring by gas analyzer of NOx
- Report to local governments

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I. Air pollution

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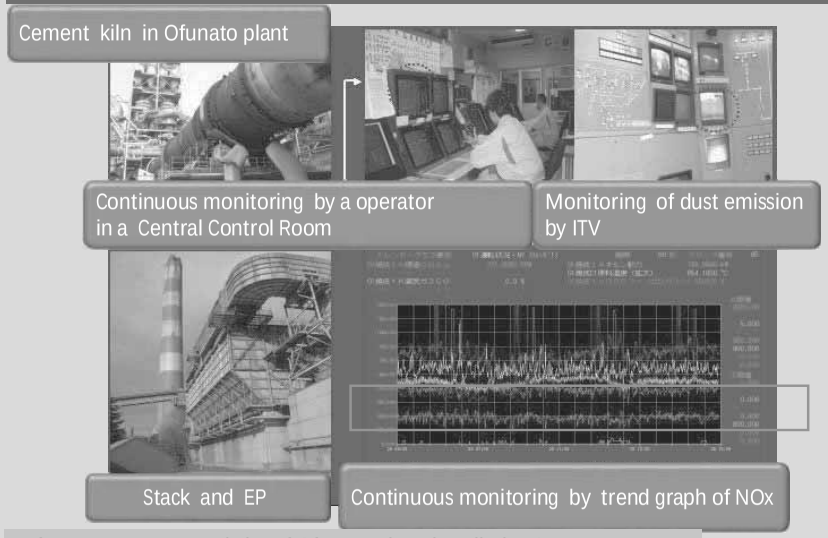
＜Examples of daily management＞



Reference: Internet website of Ofunato plant in Taiheiyo Cement Corporation

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1. Air pollution

1-1) Air pollution in a cement plant

1) Dust emission
   /EP (Electrostatic precipitator)
   /Bag filter
2) NOx
   Countermeasures are very important problems in a cement plant.

3) SOx
   SOx is almost absorbed by CaO included in raw meal in a preheater , Raw mill and dust collector such as an EP or a bag filter.
   Therefore, SOx is not so serious problem.

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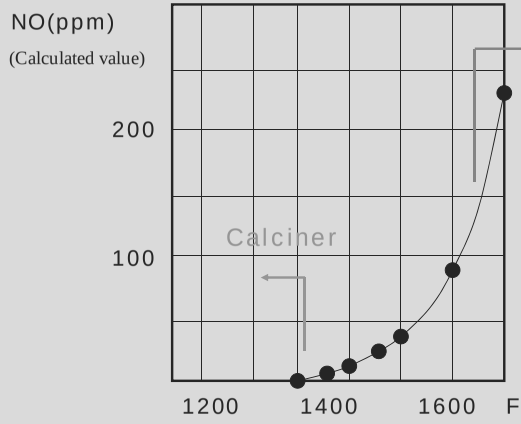
1-3) Countermeasures of NOx emission

1-3-1) NOx formation mechanism in a cement kiln

NO value is calculated from flame temperature.



Feature of NOx formed in a NSP kiln:

1) Calciner:

Only Fuel NOx is slightly formed because of lower temperature in a calciner.

2) Kiln :

Most NOx is formed in a kiln because clinker temperature is over 1450℃

Lower flame temperature ⇒NOx can be reduced

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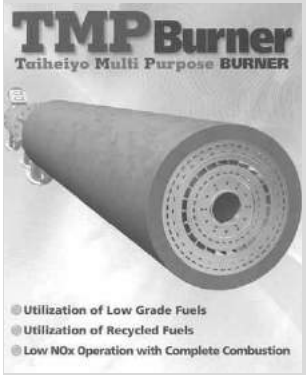
1-3) Countermeasures of NOx emission

1-3-2) Low NOx Buner（TMP- Buner）



Performance

Performance result at Taiheiyo Cement Plant, Japan

Fuel		NOx level in kiln	
		Conventional Burner	TMP Burner
Fossil fuel	Alternative fuel		30～40% decrease
Bituminous coal, Petcoke, Anthracite coal	Recycled fuel		

Level of NOx is influenced by the kind and proportion of fuels.

Comparison of Burner Flames

Main Features of TMP Burner

- Short range of Zone A → Rapid ignition
- Wide range of Zone B → Reducing NOx
- Optimization of Zone C → Complete combustion

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<Examples of daily management>

1. Emissions of which standard was enacted in law and are required periodic measurement

1) NOx,SOx,Dust emission : Once per two months
2) DXNs : Once per one month

#1 Measurement shall be implemented by external company

#2 As for NOx,SOx,dust emission, cement kiln is operated to keep less than standard value with monitoring continuously.

Reference: Internet website of Ofunato plant in Taiheiyo Cement Corporation

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<Examples of daily management>

Monitoring device of NOx,SOx

Periodic measurement

Monitoring device of dust emission

Reference: Internet website of Ofunato plant in Taiheiyo Cement Corporation

Contents	Unit	No.1 kiln	No.5 kiln	No.4 Boiler	Slag Dryer
Dust emission	g/m^3N	Less than 0.05	Less than 0.05	Less than 0.10	Less than 0.10
SOx	m^3N/h	Less than 120	Less than 190	Less than 215	Less than 15
NOx	ppm	Less than 480	Less than 480	Less than 450	Less than 230
HCl	mg/m^3N	Less than 100	Less than 100		
DXNs	$ng\text{-}TEQ/m^3N$	Less than 0.1	Less than 0.1		

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Ⅱ. Energy –saving and Utilizing waste materials

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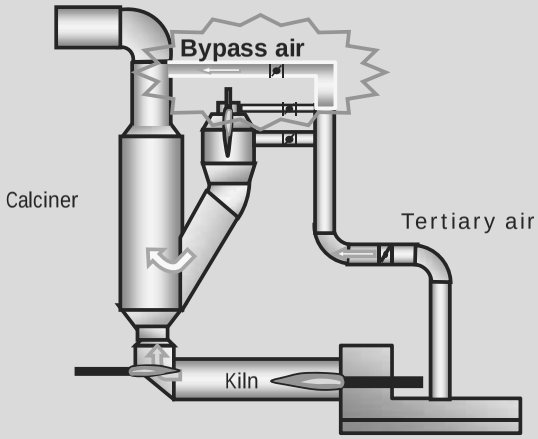
1-3) Countermeasures of NOx emission

1-3-3) Reduction method of Kiln NOx



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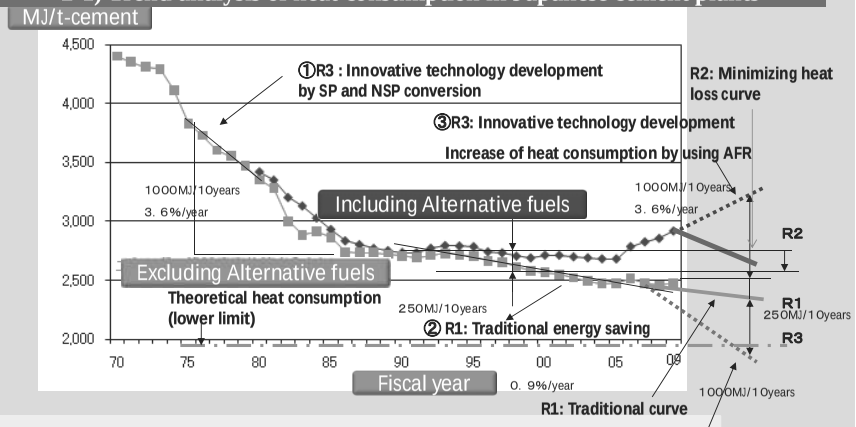
2. Energy –saving and Utilizing waste materials

2-1) Trend analysis of heat consumption in Japanese cement plants



Points to reduce heat consumption in the near future :

1) Reducing heat loss by AFR
2) Changing lower limit of heat consumption by change of clinker minerals or cement composition to reduce 8% against 1990 fiscal year.

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1-3) Countermeasures of NOx emission

1-3-4) Application of SNCR

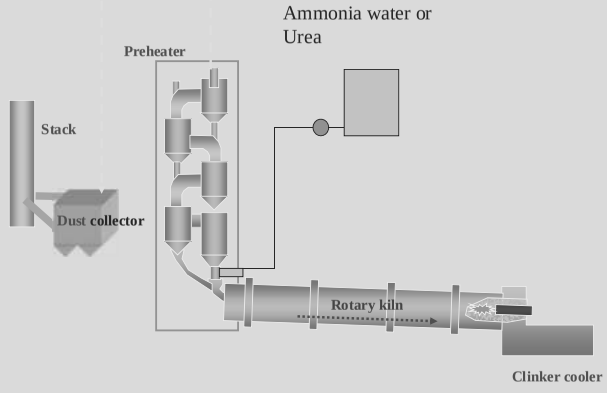
Chemical reaction:

$4NO+4NH_3+O_2 \Rightarrow 4N_2+6H_2O$

Reaction temperature:

850-1050℃

SNCR: NH_3, $(NH_2)_2CO$



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Investigation result and Countermeasure plans implemented by TEC

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2. Energy –saving and Utilizing waste materials

2-2)Representative traditional energy-saving technologies

1) SP/NSP conversion
2) Multiple-stage cyclone preheater
3) High efficiency clinker cooler
4) High momentum kiln burner
5) Conversion from a tube mill to a vertical roller mill
6) High efficiency separator
7) Pre-grinding system with tube mill
8) Speed control system of large size fan
9) Waste heat power generation

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3. Investigation result and Countermeasure plans implemented by TEC

No.1&No.2 kiln

① Scope of target

Output | Quality | Energy | CSR Safety

② Investigation equipment

Raw mill | Coal mill | Preheater Kiln Cooler | Finish mill

③ Investigation result

Bottle neck, Countermeasure

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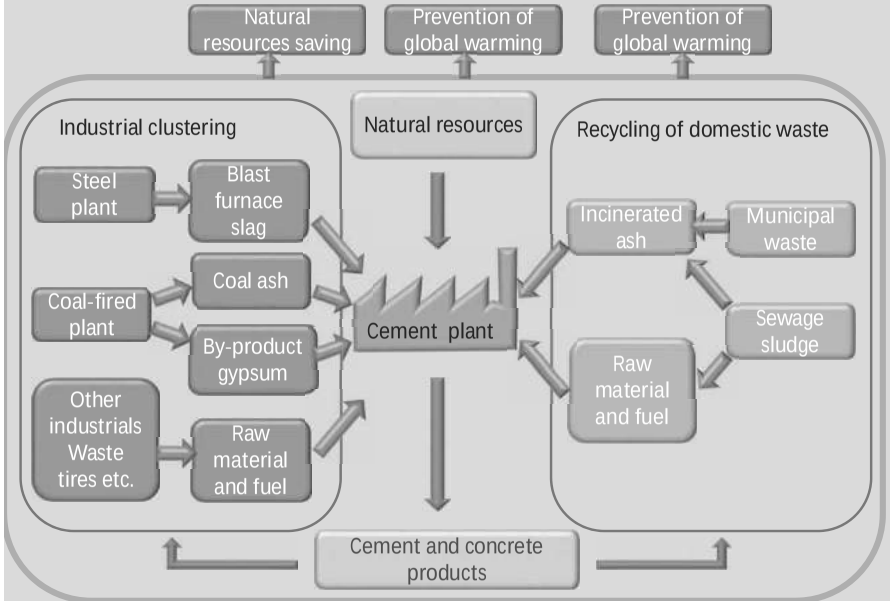
2-3) Utilizing waste materials



Thank you for your Attention

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http://www.taiheiyo-eng.co.jp

EFFECT after carrying out TEC's Plan

1) Existing

	Clinker output	Heat consumption	Exhaust gas volume of IDF
	t/d	kcal/kg-cli	m^3N/kg-cli
No.1 kiln	2050	923.4	2.02
No.2 kiln	2551	986.7	1.65

2) After modification(expected)

	Clinker output	Heat consumption	Exhaust gas volume of IDF
	t/d	kcal/kg-cli	m^3N/kg-cli
No.1 kiln	2700	840.7	1.68
No.2 kiln	2750	782.1	1.57

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NOx Reduction method from 768ppm to 323ppm

< Countermeasure >

Modification	Measured position of NOx	Unit	Existing	After modification 1 Adjustment of gas balance	After modification 2 TMP Burner+SNCR1	After modification 3 TMPburner +SNCR1+SNCR2
TMP Burner	Kiln inlet	ppm	950-1040	950-1040	850-900	850-900
SNCR1	AIDF	ppm	950-1040	950-1040	552-585	552-585
SNCR2	BIDF	ppm	220-230	220-230	220-230	143-150
	Kiln EP	ppm	768	512-554	352-372	306-324
	Kiln gas volume ratio	-	0.67	0.4	0.4	0.4

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