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Ambient Air Quality Assessment in Major Petrochemical Industrial Hubs of India

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ABSTRACT: In The Current Era Of Global Warming, Air Pollution Has Been One Of The Major Sources Of Environmental Pollution In India. Petrochemical Hubs Spread Across Various Industrial Clusters Of The Country Are A Major Source Of Air Pollution. This Paper Primarily Focuses On The Ambient Concentrations Of Pollutants, Namely Pm_{10}, So_2 And No_2 And Air Quality Indices In The Major Polluted Petrochemical Industrial Clusters Of India. Five Petrochemical Industrial Clusters Viz., Ankleshwar, Haldia, Manali, Manglore And Navi Mumbai Earlier Identified By Central Pollution Control Board, Delhi As Critically Polluted Areas In 2009 Have Been Chosen For The Present Study. Air Quality Monitoring Undertaken By Cpcb In These Industrial Clusters During 2014 To 2016 Has Been Used. Rds (Respirable Dust Sampler) Have Been Used For Measurement Of Air Quality Parameters At Various Locations Within Each Industrial Cluster. According To Our Study The Level Of Annual Average Values Of Pm10 Is Increasing In Petrochemical Clusters Like Anklesvar And Manglore And Decreasing In Navi Mumbai Which Is A Good Sign. But In Areas Like Navi Mumbai ,Haldia And Anklesvar The Annual Concentration Of Pm_{10} Is Beyond The Standard Prescribed By Cpcb For All The Years. The Level Of Ambient Annual Concentration Of So_2 And No_2 Is Under The Standard Prescribed By Cpcb. The Air Quality Index Calculated Based On Annual Average Concentration "Moderate" In Navi Mumbai In All The Years.The Aqi Range Of Haldia Is "Moderate" In The Years 2014 And 2016 Where As It's Range Is "Satisfactory" In The Year 2013.

KEY WORDS: Petrochemical Industrial Clusters; Air Quality Standards; Air Quality Index; Health Effects

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I. INTRODUCTION

Mankind In Its Endeavor For A Better Quality Living Are Not Only Depleting The Natural Resources But Also Releasing Large Amounts Of Wastes/ Pollutants In To Environment. Particulate Matter, So2 And No2 Are Among The Criteria Air Pollutants Identified By Usepa And Emitted From Petrochemical Refineries[1]. Petrochemical Industries Have Revolutionized Our Life And Are Providing The Major Basic Needs For The Growth Of The Civilization. According To A Report Indian Petrochemical Industry Has Grown ~11% In 2010-2011(Cholakov, G.) Anthropogenic And Developing Activities Directly Or Indirectly Affect Environment. This Environmental Pollution Is Deteriorating The Quality Of Air/Water/Soil Causing Environment Hazards Such As Global Warming, Acid Rains Etc. Improper Production Process, Poor Maintenance Practices And Internal Operational Process Problems Leads To Unsafe Emission (Iyar, Vijayan Gurumurthy). Petrochemical Air Sampling Measurements Reports Shows That During The Course Of Gas Leak There Were About Thirty Toxic Chemicals Get Discharged Into Atmosphere (Iyar, Vijayangurumurthy). Air Emission From The Petroleum Industry Can Be Classified As Combustion Emission Process, Fugitive Emission, Emission From Storage And Handling Of Petroleum Liquids And Secondary Emissions (Cholakov, G.).Impacts Of Petroleum Refining Are Associated With Both Manufacturing Operations And With The Use Of The Finished Products (Epa, 1995). The Major Classes Of Processes Typically Carried Out By Refineries Are Given Below-(Epa, 1995): Desalting, Atmospheric Distillation, Reforming And Extractions, Waste Recovery And Treatment, The Contamination Process Is Related To The Illegal Release Of Chemicals Into Surface Water Bodies, Air, Soil And The Water Bearing Stratums [2]. The Poor Functioning Of Systems Of Control And Abatement Of Emissions From Industrial Plants Produce The Toxic Substances (Who, 2010). Urban Air Quality Issues Are Rising Due To Growing Industrial And Developmental Activities (Cpcb, 2010). The Level Of Particulate Matters, So_x And No_x Is High In The Air Of Urban Cities. Lack Of Coherent Policy And Haphazard Construction Is Exacerbating Pollution Levels In Most Of The Indian Cities [3].Many Sampling Stations Are Made In Order To Ensure Compliance With The Location Criteria Established In The Legislation. Particulate Matters, So_x And No_x Are Recognized As Key

Pollutant With Negative Impact On The Human Health[4], In 1981, The First Ambient Air Quality Monitoring Station Was Installed In Agra, Tajmahal. Main Objective Was Study Of Effects Of So_2 Emitted By The Petrochemical Refinery In Mathura (Cpcb). This Program Was Aimed To Monitor 3 Pollutant I.E Spm, Sox, No_x In Order To Design Effective Strategies To Control Concentration Of These Pollutants In Ambient Air [5,6,7,8,9,10]. The Emission Of Particulate Matter, Sox And No_x From Petrochemical And Oil Refinery Affect Human Health [11]. Peoples Living In Vicinity Of Petrochemical Industries Faces Many Health Problems Like Skin And Respiratory Problems [12]. Harmful Gases Such As Sulphur Dioxide And No_x Causing Air Pollution And Acid Rain Can Result In Cancer, Lung, Infection And Brain Related Diseases [13]. Various Skin Diseases Also Originate From Air Pollution And 15% Among Those Born With Defects Are Born So Due To Air Pollution. Childrens And Pregnant Women Are More Vulnerable To Air Pollution [14].

II. NATIONAL AIR QUALITY INDEX (INDIA)

(Ind-Aqi) Was Developed By Central Pollution Control Board (Cpcb), Delhi And Indian Institute Of Technology Kanpur. For This Project, Cpcb Constituted An Expert Committee Was Constituted With Members Drawn From Academia, Medical Fraternity, Research Institutes, Moef, Advocacy Groups, Spcbs And Cpcb. The Committee Was Mandated To Deliberate, Discuss And Devise Consensus On The Aqi System That Is Appropriate For Indian Conditions. The Technical Study Was Assigned To Iit Kanpur On Grant-In-Aid Basis. The Objective Of An Aqi Is To Quickly Publicize Air Quality Information (Almost In Real-Time) That Entails The System To Account For Pollutants Which Have Short-Term Impacts. A New Set Of Indian National Air Quality Standards (Inaqs) For 12 Parameters Carbon Monoxide (Co) Nitrogen Dioxide (No_2), Sulphur Dioxide (So_2), Particulate Matter (Pm) Of Less Than 2.5microns Size ($Pm_{2.5}$), Pm Of Less Than 10 Microns Size (Pm_{10}), Ozone (O_3), Lead (Pb), Ammonia (Nh_3), Benzo(A) Pyrene (Bap), Benzene (C6h6), Arsenic (As), And Nickel (Ni)] . Eight Parameters (Pm_{10}, $Pm_{2.5}$, No_2, So_2, Co, O_3, Nh_3, And Pb) Having Short-Term Standards Have Been Considered For Near Real-Time Dissemination Of Aqi (1/8/24 Hrs) And Annual Standards (Except For Co And O_3) And Rest Four Parameters Have Only Annual Standards.

In This Paper We Focuses On The Petrochemical Clusters Because Of The Health Concerns Rising About Pm_{10}, Pm2.5, So_x And No_x Which Are Emitted From The Petrochemical Industries We Have Focuses About Aqi And The Emission Of Pm10, So_2 And No_2 From The Petrochemical Clusters During 2014, 2015 And 2016, That Are Ankleshwar,Haldia, Manali, Mnaglore And Navi Mumbai And Their Effects On Human Health And Major Trends. Particulate Matters Are Responsible For Many Cardiovascular And Respiratory Diseases [15]. Sulphur Dioxide And Oxides Of Nitrogen Are Irritants To The Airway, Depending On The Size Of Rspm And Where They Deposit Themselves In The Lung; They Can Cause Inflammation And Definitely Decrease The Lung Capacity, Which Makes People Breathless.

III. CITY BACKGROUND

Pollutants Are Ubiquitous And Their Presence Beyond Standard Level Is Badly Affecting Human Health And Exacerbating Environment. Increasing Industrial Activities In Urban Areas Is A Main Reason Of Environmental Pollution. So It Is Important To Identify Critically, Where It Is Important To Curtail Emission Level From The Industries And To Take Essential Mitigative Measures. To Overcome This Problem Identify The Problematic Areas, In 2009, Cpcb In Collaboration With Iit, Delhi Undergone Comprehensive Environmental Pollution Index In 88 States Of India Out Of Which 43 States Declared As Critically Polluted Areas Having Cepi Value Above 60-70 And Out Of Which 6 States Are Petrochemical Industrial Clusters.Pm10 And Pm2.5 Refers To The Particulate Matter With An Aerodynamic Diameter Less Than 10µm And 2.5µm Respectively. The Brief Description Of Study Area Is Given Below

1. Haldia (West Bengal)

Haldia Is One Of The Most Rapidly Growing Industrial Towns In The West Bengal. It Is Located At A Distance Of 125km South, West Of Kolkata And 50km Upstream From Bay Of Bengal At The Confluence Of 3 Rivers Namely, Hooghly, Haldia And Roopnarayan. Haldia Is Also One Of The Biggest Ports In The Eastern Region And The Focal Point For Industrial Developmental In West Bengal. The Population Of Hpa Has Grown From 1.38 Lakhs In 1951 To Around 4.69 Lakh In 2011 And Is Further Projected To Increase 6.26 Lakhs In 2013.

2. Manali (Tamilnadu)

Manali (13°09'n, 80°15'e) Is Chennai, Connected By Road. It Comprises An Area Of 16 Km^2, Intersected By Villages And Is Inside The Inhabited Area. Manali Has An Average Rainfall Of 6cm. The Total Population Of 28,587 Consists Of 15080 Males And 13,517 Females (Census, 2011). The Area Consists Of Various Industries Like Oil Refineries, Chemicals, Fabric Yarn And Steel Etc. There Are 28 Categories Of Industries Located In Manali (Major -20, Minor- 3 And Small- 5), Which Include Cocl, Mfl, Manali

Petrochemical Etc.Increase In Industrial And Developmental Activities Has Worsened The Air Quality Of Manali.

3. Navi Mumbai (Maharashtra)

Navi Mumbai Has Tropical Climate With Mean Annual Temperature Of 23.3° (Min.) To 34.9° (Max). The Population Pressure On The City Is Ever Growing. As Per The 2001 Census The Population Of The Residential Area Around The Industrial Area Of Navi Mumbai Is About 7.5 Lacs No's And As Per Growth Rate Considered ,The Present Population Is About 26 Lacs.

4. Manglore (Tamilnadu)

Baikampady Industrial Cluster, Manglore Is Located In Dakshina Kannada District Is Having 5 Taluks Namely Manglore, Bantwala, Sullia, Bethangady And Puttur. Manglore Is Located At 12°-52'n Latitude And 74°49'e Longitude. The City Is Located In The Confluence Of Nethrarathi And Gurupura Rivers. It Is Bound In The East By Western Ghats And In The West By Arabian Sea. Manglore Is Headquarters Of Dakshina-Kannada District, Largest City In The State. The Baikampady Industrial Area Is Having 304 Operating Industries.

5. Ankleshwar (Gujarat)

Ankleshwar,Is A City And A Municipality In The Bharuch District Of The State Of Gujarat, India. The Town Is Known For Its Industrial Township Called Gidc (Gujarat Indutrial Development Corporation). Ankleshwar Has An Office Of The Ongc (Oil And Natural Gas Corporation Ltd). Ankleshwar Industrial Estate Set Up By Gujarat Industrial Development Corporation In 1975. This Industrial Estate Is Spread Over An Area Of 1574.34 Hectares In Close Proximity To National Highway No.8 And Delhi-Mumbai Railway Line. (Http://Cpcb.Nic.In/Progress-Report-Action-Plans/)

IV. IMPACT OF PETROCHEMICAL INDUSTRIES ON AIR QUALITY

Increase In Anthropogenic And Industrial Activities Has Exacerbated The Air Quality And Has Made The Air Worse To Breathe. The Emission Of Harmful Chemicals From The Industries Like Benzene, Sox, Nox, Particulate Matters Etc, Has Made The Peoples To Suffer A Lot. The Concentration Of Pollutant In The Ambient Air Is More Than The Standards Set By Cpcb. The Concentration Of Industrial Activities – Especially Those Of Large-Scale Petrochemical, Power Generation, Heavy Industry And Mining – Involves Environmental Pressures, With Potential Adverse Effects On The Health Of Local Communities Through Their Occupational And Residential Roles (Who, 2009).Contact With Polluting Substances Can Harm Human Organs – Including Respiratory, Hematopoietic, Hepatic And Renal Organs – Through Long Term And Short Term Exposure. Many Substances, For Example, Are Either Known Or Suspected Carcinogens.

Petrochemical Contamination Involves An Immense Range Of Chemicals And Adverse Effects On Health Which Are Also Common To Other Industrial Activities (Intrinsik Environmental Sciences Inc. & Stantec Consulting Ltd, 2010). It Is Necessary To Generate Hypotheses About Contaminants Of Concern That May Be Associated With A Particular Source And Use, Such As A Manufacturing Operation, Laboratory, Mode Of Transport, Disposal Area Or Waste Site (Who, 2010). The Known Burden Of Disease Worldwide Due Only To Chemicals Is Considerable. The Effects Of Industrial Activities Are Complex, Because Pollutants Have Become Ubiquitous In The Environment. Air Pollution Is A Serious Concern All Around The Globe.

Table 1: National Ambient Air Quality Standards (India)

S.No	Pollutant	Time Weighted Average	Concentration In Ambient Air	
			Industrial,Residencial,Rural And Other Area	Ecologically Sensitive Area(Notified By Central Government)
1	Sulphur Dioxide(So_2),µg/M^3	Annual 24 Hours**	50 80	20 80
2	Nitrogen Dioxide(No_2),µg/M^3	Annual 24 Hours**	40 80	30 80
3	Particulate Matter (Size Less Than 10 µm) Or Pm_{10} µg/M^3	Annual 24 Hours**	60 100	60 100

(Source:Cpcb Notification No.B-29016/20/90/Pci-I)

Data Used

We Have Used The Data Of Cpcb, Which Was Collected By Cpcb, Delhi For The Years 2014, 2015 And 2016. The Data Was Collected Under The Program Of Namp (National Air Quality Monitoring Programme).

V. METHODOLOGY

To Check The Ambient Air Concentration Of Pm10, So_x And No_x In Different Petrochemical Cluster The Sampling Was Done By Cpcb At Different Locations In Ankleshwar, Haldia, Manali, Manglore, Navi Mumbai And Panipat. The Sampling Was Done With The Help Of Rds (Repairable Dust Sampler)/ Hvs (High Volume Sampler).While Sampling Ambient Air Pollutants, It Is Necessary To Collect Information On Qualitative And Quantitative And Data On The Local Sources Of Air Pollution, Topography, Population And Climatology.

Table.2 The Different Analytical Methods Adopted By The Cpcb For The Analyses Of Concentration Of The Pollutant (Pm10, Sox And Nox)

Pollutants	**Analytical Methods Adopted**
Pm10	Gravimetric Method(Is 5182 Part 23 Method Of Measurement Of Air Pollution: Respirable Suspended Particulate Matter (Pm10) Cyclonic Flow Technique) And Cpcb Manual
So_2	Modified West & Gaeke Method (Is 5182 Part 2 Method Of Measurement Of Air Pollution: Sulphur Dioxide) And Cpcb Manual
No_2	Modified Jacob & Hochheiser Method (Is 5182 Part 6 Methods For Measurement Of Air Pollution: Oxides Of Nitrogen) And Cpcb Manual

The Above Table Delineates The Methods Adopted By Cpcb In 2014, 2015 And 2016 For The Analysis Of Pollutant In The Ambient Air.

Calculation Of National Air Quality Index (India) And Sub-Indices

Primarily Two Steps Are Involved In Formulating An Aqi: (I) Formation Of Sub-Indices (For Each Pollutant) And (Ii) Aggregation Of Sub-Indices To Get An Overall Aqi. Sub-Index Function Represents The Relationship Between Pollutant Concentration Xi And Corresponding Sub Index Ii. It Is An Attempt To Reflect Environmental Consequences As The Concentration Of Specific Pollutant Changes. It May Take A Variety Of Forms Such As Linear, Non-Linear And Segmented Linear. Typically, The I-X Relationship Is Represented As Follows:

$I = Ax + B$

Where, A =Slope Of The Line, B = Intercept At X=0.

The General Equation For The Sub-Index (Ii) For A Given Pollutant Concentration (C_p); As Based On 'Linear Segmented Principle' Is Calculated As:

$Ii = [\{(I_{hi} - I_{lo})/(B_{hi} - B_{lo})\} * (C_p - B_{lo})] + I_{lo}$

Where,

B_{hi}= Breakpoint Concentration Greater Or Equal To Given Concentration.

B_{lo}= Breakpoint Concentration Smaller Or Equal To Given Concentration.

I_{hi} =Aqi Value Corresponding To B_{hi}

I_{lo} = Aqi Value Corresponding To B_{lo}

I_p = Pollutant Concentration

Similarly, Sub Index Can Be Calculated For Other Pollutants As Well.

Aggregation Of Sub Index

I = Aggregated Index = ∑Wiii (For I= 1, …..,N)

Where,

$\sum W_i = 1$

Ii= Sub-Index For Pollutant I

N = Number Of Pollutant Variables

W_i = Weightage Of The Pollutant

Root-Sum-Power Form (Non-Linear Aggregation Form)

I = Aggregated Index = $[\sum I_i^P]^{(1/P)}$
Where,
P Is The Positive Real Number >1.
Root-Mean-Square Form
I = Aggregated Index = $\{1/K (I_1^2 + I_2^2 + \ldots\ldots + I_k^2\}^{0.5}$
I = Min Or Max (I_1, I_2, I_3, ..., I_n)

Air Quality Index
In This Aqi, A Maximum Operator System Has Been Adopted Which Is Free From Ambiguity And Eclipsing, As Shown Below:
Aqi=Max (I_1, I_2, I_3,..., I_n)
To Present Status Of The Air Quality And Its Effects On Human Health, The Following Description Categories Have Been Adopted For Ind-Aqi Table .

Table 3: Ind-Aqi Category And Range

Aqi Category	**Aqi Category**
Good	0 – 50
Satisfactory	51 – 100
Moderately-Polluted	101 – 200
Poor	201 – 300
Very Poor	301 – 400
Severe	401 - 500

Health Impacts
The Health Impacts Of Emissions From Petrochemical Industries Are Very High. The Emission Of Pm10, Pm2.5, Sox And Nox Exacerbate Human Health And Deteriorate Ambient Air Quality. In Petrochemical Industrial Clusters The Presence Of Pollutant Like Pm, So_x And No_x Is Very High In Ambient Air, And It Affects The Health Of Peoples Living In Vicinity To Petrochemical Industrial Clusters. Pm_{10} Is Associated With The Cardiovascular Pulmonary, Lung Cancer, Many Other Lung Infections And Chronic Heart Related Problems. Long And Short Term Exposure To $Pm_{2.5}$ Cause Premature Death And Adverse Cardiovascular Affects, Including Increase The Chances Of Heart Attack And Strokes. It Also Leads To The Chances Of Harmful Reproductive Efficiency And Is Also Responsible For Infant Mortality And Low Birth Rate. It Is Also Associated With Asthma Attacks, Reduces Lung Functioning Constriction Of The Airways Of Lung, Precursor To Secondary Pm And Therefore Contributes To The Ill Health's Caused By Pm_{10} And $Pm_{2.5}$. Potential Damage To Ecosystem At High Levels, Including Degradation Of Chlorophyll, Reduced Photosynthesis. Inflammation Of Airways, Long Term Exposure Can Affects Lung Functions And Respiratory Symptoms, Also Enhances Response To Allergens In Sensitive Individuals. High Level Of No_x Can Effect On Vegetation, Including Leaf Or Needle Damage And Reduced Growth.

VI. RESULTS AND DISCUSSION

Table 4: The Annual Average Concentration Of Pm_{10} In Petrochemical Clusters During The Years 2014, 2015 And 2016.

S.No	**Petrochemical Industrial Clusters**	**Annual Average Concentration Of Pm_{10} In µg/M^3 Standard Value (Cpcb) – 60(Annual)**								
		2014			**2015**			**2016**		
		Min	**Max**	**Avg**	**Min**	**Max**	**Avg**	**Min**	**Max**	**Avg**
1.	Ankleshwar	69	112	89	79	97	88	83	141	104
2.	Haldia	66	286	136	46	151	87	49	209	104
3.	Manali	25	105	45	25	66	42	25	122	58
4.	Manglore	15	61	32	13	53	36	17	62	40
5.	Navi Mumbai	43	479	152	35	229	125	35	257	119

Above Clearly Delineates That, The Annual Average Concentration Of Pm_{10} In Three Cities Namely Ankleshwar ,Haldia And Navi Mumbai Is Above The Standards Prescribed By The Cpcb During The Years 2014,2015 And 2016. Pm_{10} In Two Cities Namely Manali And Manglore Within The Standards Prescribed By The Cpcb During The Years 2014, 2015 And 2016.The Concentration Of Pm10 Is Increasing In 2014 To 2016 In Manglore. The Concentration Of Pm10 Is Decreasing In 2014 To 2016 In Navi Mumbai. It May Be Because Of The Tighter Emission Control And Proper Action Plan Implementation. The Graph Given Below Shows The Minimum And Maximum Variation Of Pm_{10} In Different Petrochemical Clusters. The Box Plot With Larger Height Shows More Variation And Box Plot With Small Size Shows Less Variation. In 2014, 2015 And 2016 Navi Mumbai With Bigger Box Plot Shows More Variation And Anklesvar With Small Box Plot Shows Small Variation.

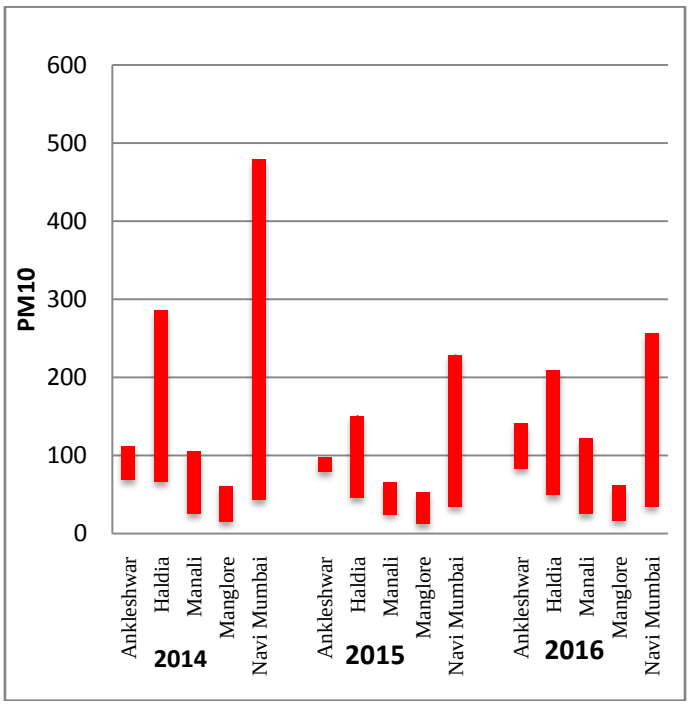

Fig: 1 Maximum And Minimum Variation Of Pm_{10} Concentration (Annual)

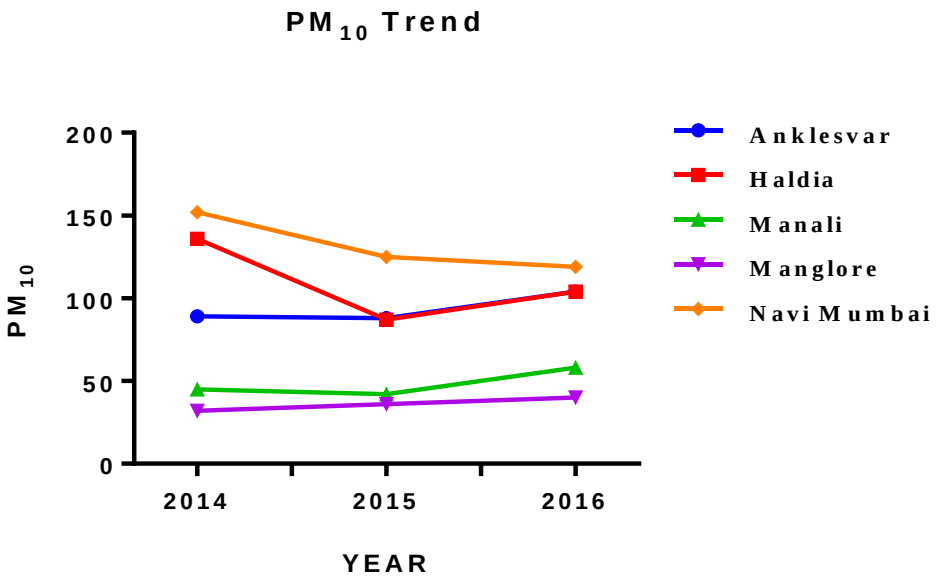

Fig :2 Variation Of Annual Average Concentration Of Pm10 In µg/M3

Table 4: The Annual Average Concentration Of So_2 In Petrochemical Clusters During The Years 2014, 2015 And 2016

S.No.	Petrochemical Industrial Clusters	Annual Average Concentration So_2 In µg/M^3 Standard Value (Cpcb) -50(Annual)								
		2014			2015			2016		
		Min	Max	Avg	Min	Max	Avg	Min	Max	Avg
1.	Ankleshwar	12	25	16	13	17	15	7	29	12
2.	Haldia	06	58	11	02	15	03	11	38	18
3.	Manali	09	20	13	9	19	13	10	18	14
4.	Manglore	03	14	08	03	13	7	02	14	07
5.	Navi Mumbai	10	28	18	8.5	35	19	11	33	20

The Annual Average Concentration Of So_2 Is Decreasing From 2011 To 2013 In Anklesvar And Manglore. It Shows That, The Emission Of Sox Is Under Control. It May Be Because Of The Tighter Emission Control And Proper Action Plan Implementation. So_2 Is Increasing From 2011 To 2013 In Navi Mumbai And Manali. The Graph Given Below Shows The Variation In Minimum And Maximum Value Of So_2. In 2014 Haldia Shows Highest Variation Whereas Manali, Mangalore,Anklesvar And Navi Mumbai Shows Less Variation. Similarly, The Graph For 2015 Clearly Delineates That Navi Mumbai Shows More Variation And Ankalesvar Shows Less Variation. But In All The Clusters Annual Average Is Always Less Than The Standard Limit Prescribed By Cpcb Which Is A Good Sign

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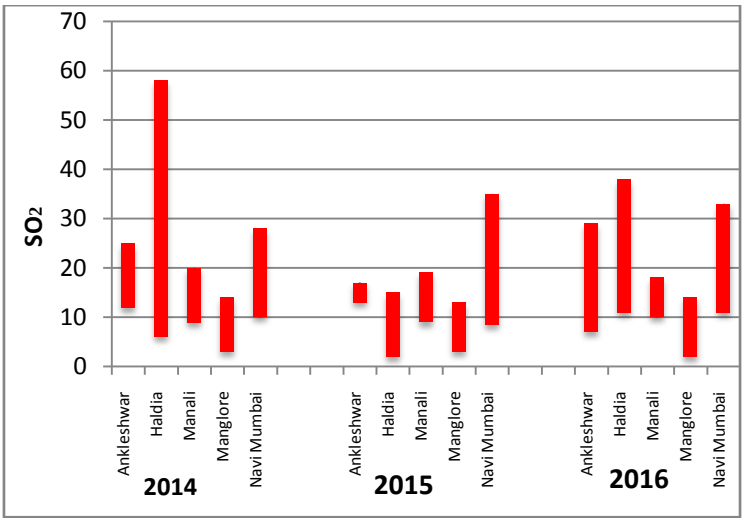

Fig:3 Maximum And Minimum Variation Of So_2 Concentration (Annual)

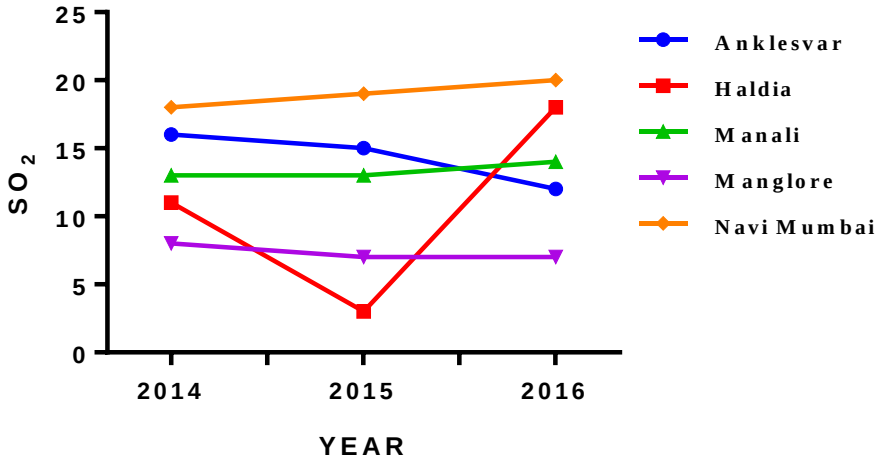

Fig: 4 Variation Of Annual Average Concentration Of So_2 In µg/M3

Table 5: The Annual Average Concentration Of No_2 In Petrochemical Clusters During The Years 2014, 2015 And 2016.

S.No	Petrochemical Industrial Clusters	Annual Average Concentration Of No_2 In µg/M^3 Standard Value(Cpcb) -40(Annual)								
		2014			2015			2016		
		Min	Max	Avg	Min	Max	Avg	Min	Max	Avg
1.	Ankleshwar	15	26	22	19	23	21	10	37	21
2.	Haldia	19	52	38	11	32	17	34	69	42
3.	Manali	10	20	15	11	23	17	13	26	17
4.	Manglore	05	11	07	4.5	11	07	05	14	09
5.	Navi Mumbai	21	58	40	18	73	43	20	68	47

The Average Annual Concentration Of No_2 Is Increasing From 2014 To 2016 In Navi Mumbai And In 2015 And 2016, It Reaches Beyond The Limit Prescribed By Cpcb Which Is Not A Good Sign. In Haldia No_2 Concentration Beyond The Limit Prescribed By Cpcb In 2016.Remaining All Cities It Is Within The Prescribed Limit. In Navi Mumbai The Graph Shows More Variation In All The Years.

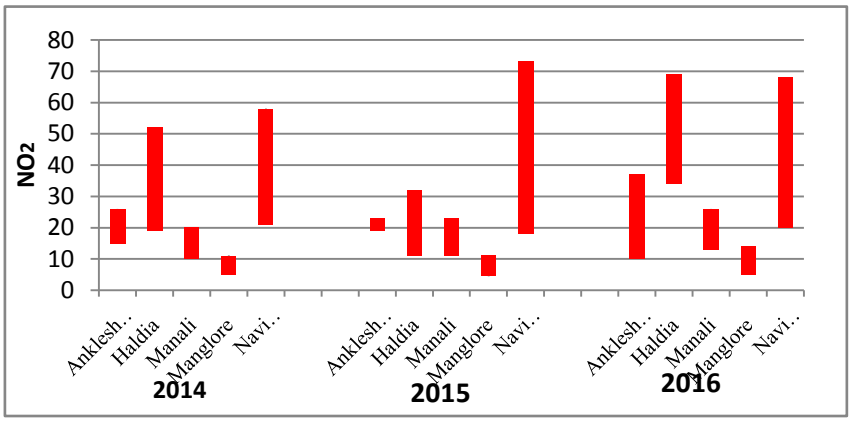

Fig:5 Maximum And Minimum Variation Of No_2 Concentration (Annual)

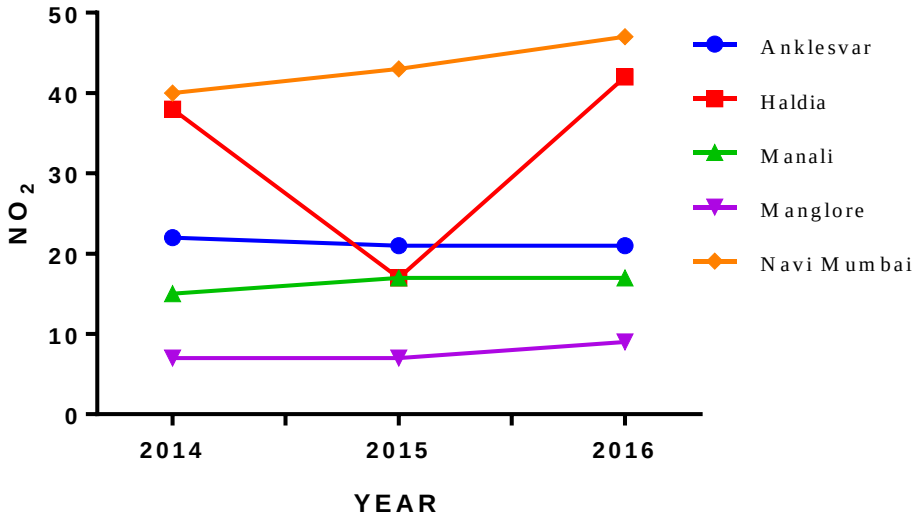

Fig: 6 Variation Of Annual Average Concentration Of No_2 In µg/M3

Air Quality Index

Table 6: Summary Of 24h Average, Minimum And Maximum Aqi For Pm_{10}, So_2 And No_2 During The Years 2014, 2015 And 2016.

S.NO	Petrochemical industrial clusters	Year	AQI								
			PM_{10}			SO_2			NO_2		
			MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG
1.	ANKLESWAR	2014	68	108	89	15	31	19	18	33	27
		2015	79	97	88	16	21	19	24	29	26
		2016	83	127	102	09	36	15	13	46	26
2.	HALDIA	2014	66	236	124	8	73	14	24	65	48
		2015	46	87	87	3	19	19	14	40	22
		2016	49	109	109	14	49	23	42	86	27
3.	MANALI	2014	25	104	45	12	25	17	13	25	19
		2015	25	66	42	12	24	17	14	29	22
		2016	25	115	58	13	23	18	17	33	22
4.	MANGALORE	2014	15	61	32	04	18	10	07	14	09
		2015	13	53	36	04	17	09	07	14	09
		2016	17	62	40	03	18	09	07	18	12
5.	NAVI MUMBAI	2014	43	468	134	13	35	23	26	72	50
		2015	35	185	117	11	44	23	22	91	53
		2016	35	206	113	14	42	25	25	85	59

In Navi Mumbai Aqi Category Based On Annual Is 'Moderate', Which Is Not Good Sign. The Maximum Value Is In Alarming State .Steps Has To Taken To Improve The Air Quality In Navi Mumbai. In Manali And Manglore The Aqi Category Is 'Good' Which Does Lead Minimal Effect. In 2014 And 2016 The Aqi Category In Haldia Is 'Moderate'.Neccessary Action Plan Is Required To Improve Air Quality In Haldia And Navi Mumbai To Maintain The Air Quality In Good Condition.

Table 7: Breakpoints For Aqi Scale 0-500 (Units: Mg/M^3 Unless Mentioned Otherwise) And Health Statements For Aqi Categories

Aqi Category (Range)	Associated Health Impacts	Pm_{10} 24-Hr	So_2 24-Hr	No_2 24-Hr
Good (0-50)	Minimal Impact	0-50	0-40	0-40
Satisfactory (51-100)	May Cause Minor Breathing Discomfort To Sensitive People	51-100	41-80	41-80
Moderate (101-200)	May Cause Breathing Discomfort To The People With Lung Disease Such As Asthma And Discomfort To People With Heart Disease, Children And Older Adults	101-250	81-380	81-180
Poor (201-300)	May Cause Breathing Discomfort To People On Prolonged Exposure And Discomfort To People With Heart Disease With Short Exposure	251-350	381-800	181-280
Very Poor (301-400)	May Cause Respiratory Illness To The People On Prolonged Exposure. Effect May Be More	351-430	801-1600	281-400

	Pronounced In People With Lung And Heart Diseases			
Severe (401-500)	May Cause Respiratory Effects Even On Healthy People And Serious Health Impacts On People With Lung/Heart Diseases. The Health Impacts May Be Experienced Even During Light Physical Activity	430+	1600+	400+

*One Hourly Monitoring (For Mathematical Calculation Only) Cpcb May Consider Reviewing The Aqi Breakpoints Every Three Years After Accounting The New Research Findings On Air Pollution Exposure And Health Effects. (Source: Control Of Urban Pollution Series : Cups/ 87 /2014-2015)

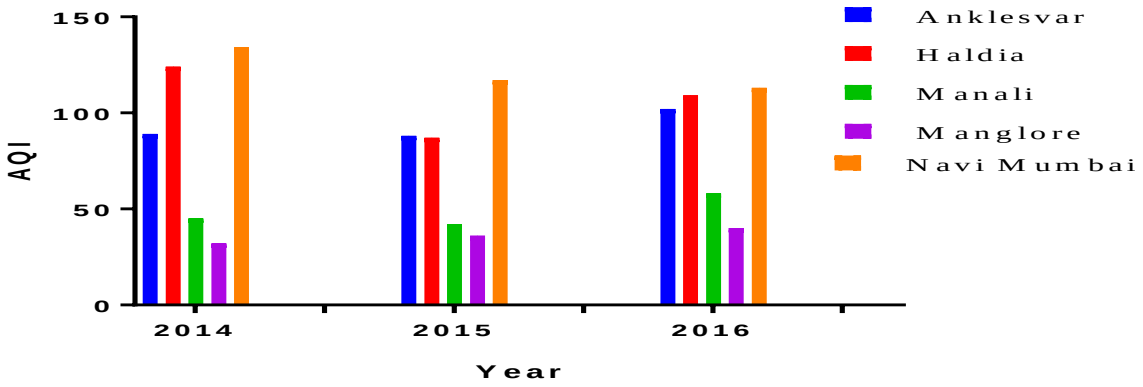

Figure : 7 Comparison Of Aqi Values During The Years 2014,2015 And 2016 In Petrochemical Clusters

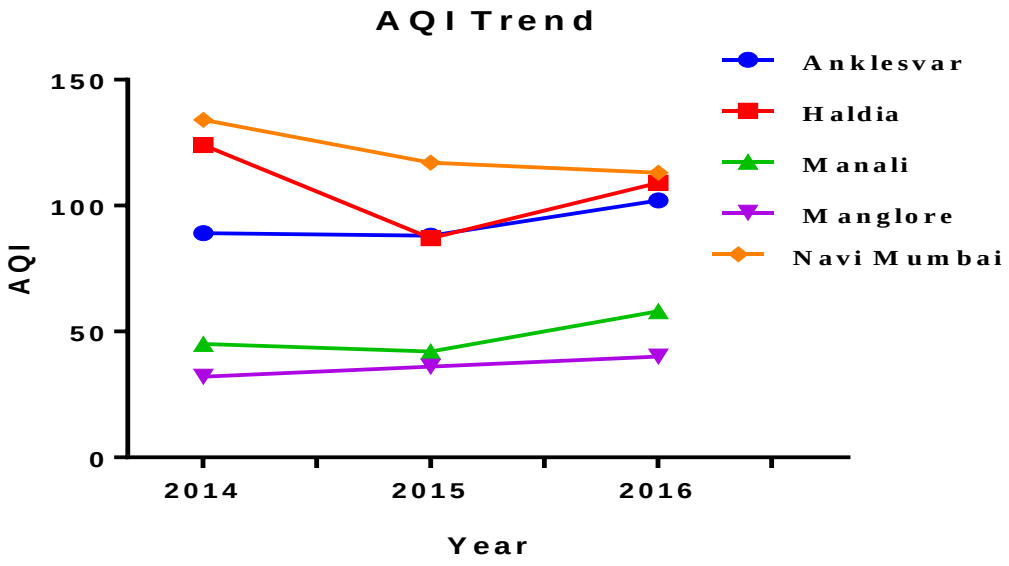

Figure: 8 Variation Aqi (Annual) Average Values

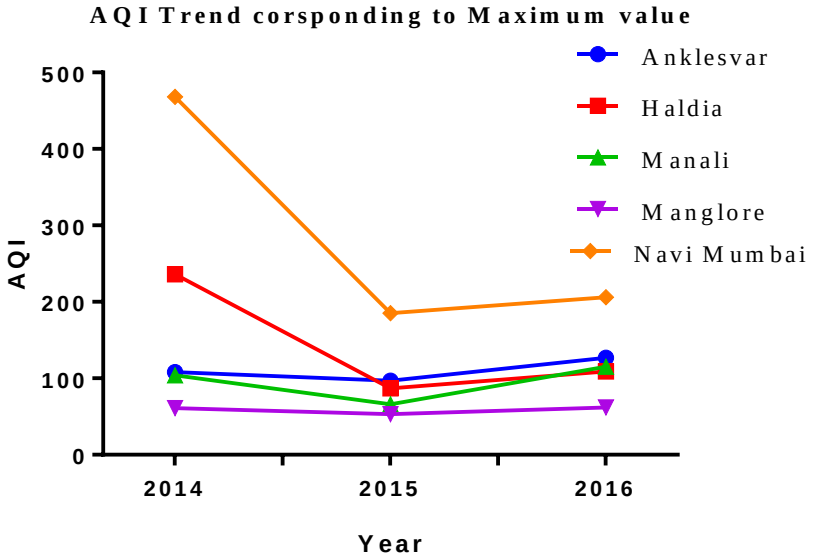

Figure: 9 Variation Of Maximum Aqi Values

VII. CONCLUSION

Annual Average Concentration Of Pm_{10} In Petrochemical Clusters Is Above The Prescribed Standard Limit In Three Cities,Ankleswar ,Haldia And Navi Mumbai. Strict Emission Control Should Be Require In This Three Industrial Clusters. Annual Average Concentration Of No2 In Navi Mumbai Is Beyond The Prescribed Limit. Various More Emission Control Methods To Be Adopted In Navi Mumbai. Air Quality Improvement Is Needed In Two Cities Navi Mumbai And Haldia By Decreasing The Aqi Values Less Than 50.

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