AIR POLLUTION, FUELS, EMISSION

e-learning material

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AIR POLLUTION, FUELS, EMISSION

Normal atmospheric composition:

- 78% nitrogen,
- 21% oxygen,
- less than 1% of argon,
- a little helium, neon, krypton.

AIR POLLUTION, FUELS, EMISSION

- According to the World Health Organization, people who died from air pollution more than the number from AIDS, tuberculosis and auto accident in common.
- Air pollution brings the high cost to the economy and damage to the nature.
- Air pollution affects to climate change.
- Carbon dioxide and methane raises the earth's temperature.
- Smog – weather is warmer and there's more ultraviolet radiation.

AIR POLLUTION, FUELS, EMISSION

WHO data indicate that reducing atmospheric pollution by 50%:

- age of the population prolong 3-5 years,
- The average annual incidence and mortality reduction 35%,
- lung cancer and other respiratory disease – 20-30%,
- cardiovascular diseases – 10%.

AIR POLLUTION, FUELS, EMISSION

Biosphere includes three environments:

- Hydrosphere – Earth planets waters.
- Litosfer – solid globe sphere (up to 120 km thick).
- Earth's atmosphere – globe surrounds the air layer, which protects against cosmic radiation.

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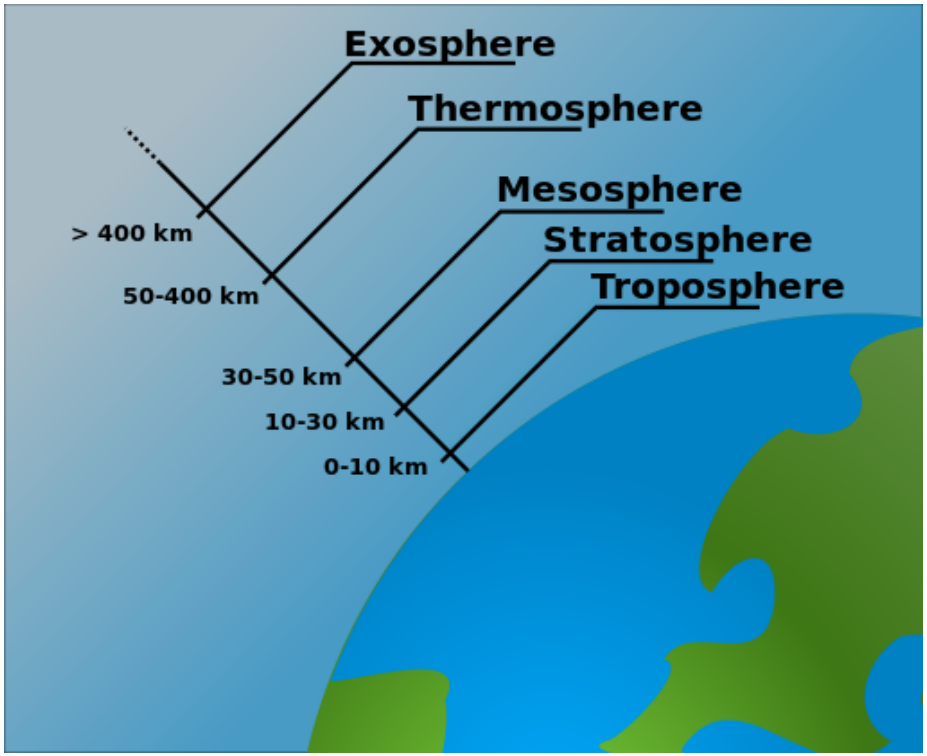
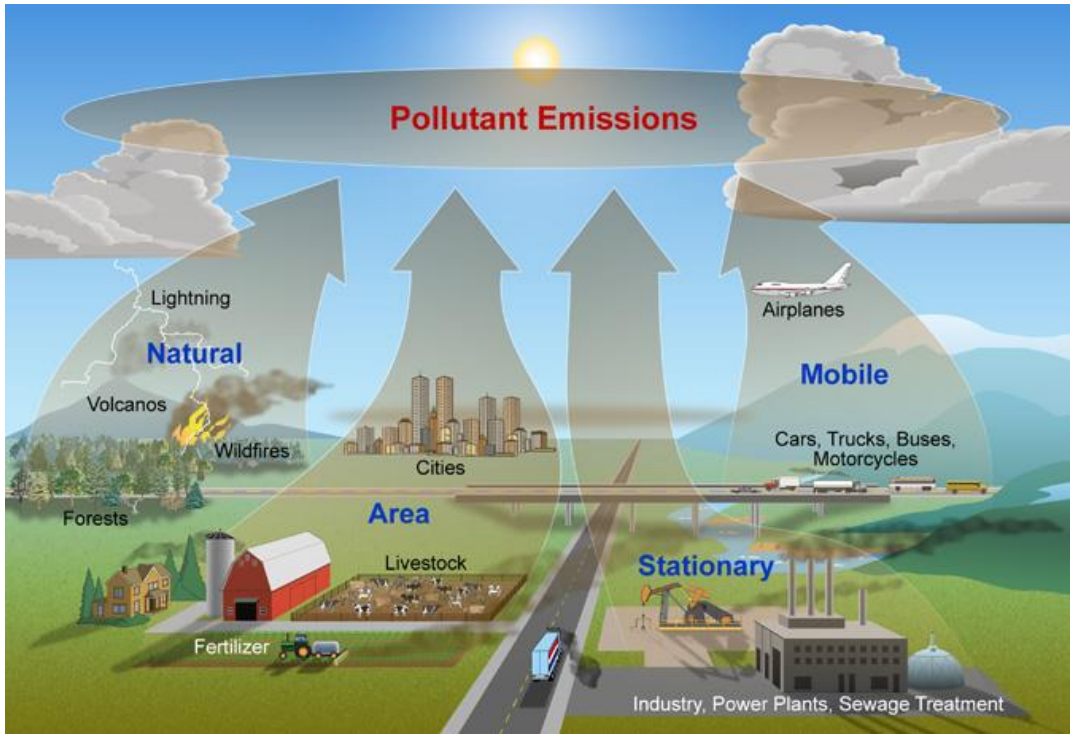


https://www.niwa.co.nz/education-and-training/schools/students/layers

AIR POLLUTION, FUELS, EMISSION. AIR POLLUTERS.

- Air pollution, from energy use and production, coming from human activity.
- Emissions from cars and trucks, factories, power plants.
- Anthropogenic pollutants-produced by humans (sulfur dioxide is produced by fossil fuel combustion).
- Natural pollutants-volcanic activity, forest fires.

AIR POLLUTION, FUELS, EMISSION

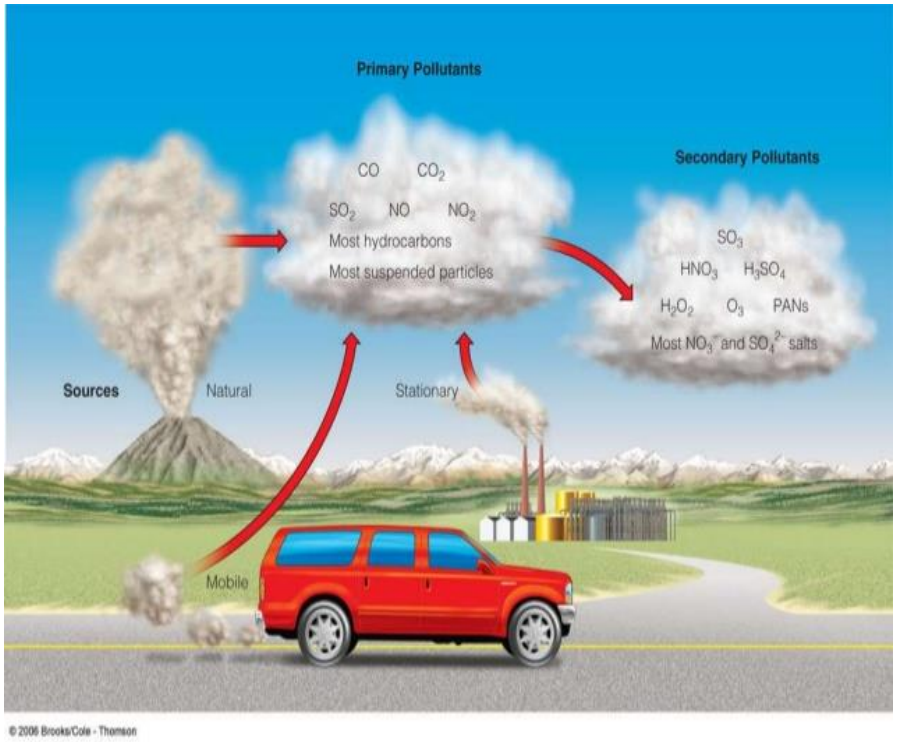


https://www.nature.nps.gov/air/aqbasics/sources.cfm

AIR POLLUTION, FUELS, EMISSION. EXAMPLES OF AIR POLLUTANTS.

- **Sulfur oxides (SO_x)** – particular (SO_2), fossil fuels, coal and oil contain sulfur to differing degrees.
- Stationary fuel combustion – 73.5%;
- Industries – 22.0%;
- Transportation – 2.4%;

Extremely dangerous (SO_2) compounds of atmospheric water vapor, which becomes acidic rain.



https://www.slideshare.net/MalihaEesha/air-pollution-its-causeseffects-and-pollutants

AIR POLLUTION, FUELS, EMISSION. EXAMPLES OF AIR POLLUTANTS

- **Nitrogen oxides (NOX)** – nitrogen oxide (NO) and nitrogen dioxide (NO2): NOX stem from high-temperature combustion,
- Transport – 39,3 %;
- Stationary fuel combustion – 48,5 %;
- Industry – 1.0%;

  Oxidation of NO to NO2 in the atmosphere. NO2 is a toxic gas and can lead to the formation of particulate matter and ozone.

AIR POLLUTION, FUELS, EMISSION. EXAMPLES OF AIR POLLUTANTS

- **Particulate matter (PM)** – mix of solid/liquid organic and inorganic substances. “coarse particles” are between 2.5 and 10 micrometres (μm) in diameter and “fine particles” are smaller than 2.5 μm. Black carbon, a particular type of fine PM, is formed by the incomplete combustion of fossil fuels and bioenergy, and is a short-lived climate pollutant.

http://zeenews.india.com/news/eco-ews/particulate-matter-exposure-in-india-higher-than-in-china_1858120.html

AIR POLLUTION, FUELS, EMISSION. EXAMPLES OF AIR POLLUTANTS

- **Carbon monoxide (CO) –** colourless, odourless, toxic gas that comes from the incomplete combustion of natural gas, coal or wood, road transport fuels.
- **Ammonia (NH3)** – released in relation to agricultural and waste management activities; in the atmosphere ammonia reacts with oxides of nitrogen and sulfur to form secondary particles.

AIR POLLUTION, FUELS, EMISSION. EXAMPLES OF AIR POLLUTANTS

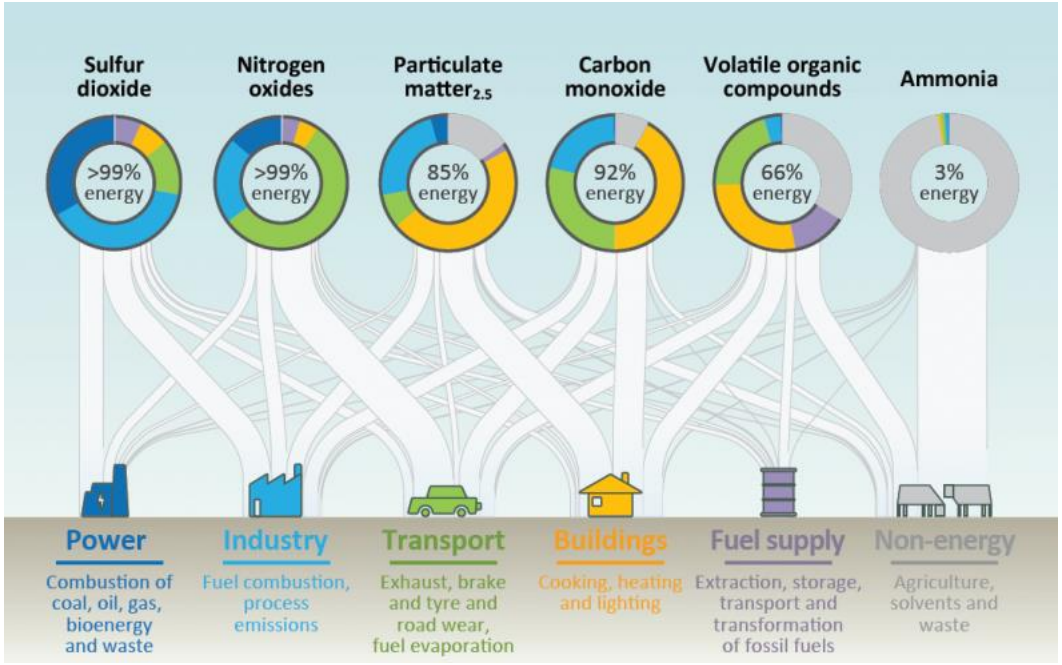
- **Volatile organic compounds (VOCs)** – released from chemicals, solvents or fuels. Methane (CH4), the main component of natural gas.
- **Ground-level ozone (O3)** – formed from NOX and VOCs in the presence of sunlight. At high concentrations, ozone is a pollutant and a short-lived climate pollutant.

AIR POLLUTION, FUELS, EMISSION

Air pollutant emissions (mln. tons per year)

POLLUTANT	FORMULA	NATURALLY GENERATED	FOR THE ACTIVITIES
Carbon dioxide	CO2	1 000 000	22 000
Carbon oxide	CO	2 100	700
Sulfur oxide	SO2	20	212
Methane	CH4	1 050	160
Carbohydrates	CnHm	20 000	40
Nitrogen oxides	NOx	180	75
Ammonia	NH3	260	6
Hydrogen sulfide	H2S	84	3

AIR POLLUTION, FUELS, EMISSION



http://www.sutp.org/en/news-reader/world-energy-outlook-special-report-2016-on-air-pollution-released-9039.html

AIR POLLUTION, FUELS, EMISSION

EU directives:

- 96/62/EC on ambient air quality assessment and management.
- 1999/30/EC relating to limit values for sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particulate matter and lead in ambient air.
- 2000/69/EC relating to limit values for benzene and carbon monoxide in ambient air.
- 2002/3/EC relating to ozone in ambient air.
- 2004/107/EC relating to arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air.

AIR POLLUTION, FUELS, EMISSION

EU directives:

- 96/61/EC concerning integrated pollution prevention and control.
- 2001/81 EC on national emission ceilings for certain atmospheric pollutants.
- 2001/80/EC the operators of existing and new solid fuel-fired large combustion plants.

AIR POLLUTION, FUELS, EMISSION

EU directives:

- 94/63/EC on the control of volatile organic compound (VOC) emissions resulting from the terminals to service stations.
- 1999/13/EC on the limitation of VOC from certain activities and certain devices.
- 2004/42/EC on the limitation of VOC due to the use of organic solvents in certain paints and varnishes and vehicle refinishing products, capping.

AIR POLLUTION, FUELS, EMISSION

EU directives:

- 2000/76/EC on the requirements for waste incineration.
- 70/220/EC on the emissions of road transport vehicles rationing.
- 97/68/EC on the emissions of pollutants from road mobile machinery rationing.
- 1999/94/EC relating to the availability of consumer information on fuel economy and CO2 emissions in respect of the marketing of new passenger cars.

AIR POLLUTION, FUELS, EMISSION. LARGE COMBUSTION PLANTS

From 2008-01-01 to existing LCPs subject to new requirements.

- Existing LCPs with installed capacity of more than 100 MW of 2008-01-01 mandatory auto emissions monitoring.
- New LCPs were put into operation after 2002 even more stringent requirements.

AIR POLLUTION, FUELS, EMISSION

SO_2 RATES ON NEW LCPs
(A GAS FUEL)

- Gaseous fuels (generally) – 35 mg/Nm^3
- Liquid gas – 5 mg/Nm^3
- Low-calorie gas – 800 mg/Nm^3

AIR POLLUTION, FUELS, EMISSION

NOx RATES ON NEW LCPs

- Liquid fuels
- 50 – 500 MW 450 mg/Nm^3
- >500 MW 400mg/Nm^3

- Gaseous fuels
- 50 – 500 MW 300 mg/Nm^3
- >500 MW 200 mg/Nm^3

AIR POLLUTION, FUELS, EMISSION

PARTICULATE MATTER RATES ON NEW LCPs

- Liquid fuels
  -All devices 50 mg/Nm^3
  - < 500 100 mg/Nm^3 (pel. > 0,06%)

- Gaseous fuels
  -All devices 5 mg/Nm^3

AIR POLLUTION, FUELS, EMISSION. MULTI-FUEL LCPs LIMITS

- For each type of fuel and pollution, separately determined limit value for combustion plant, according to the nominal thermal power.
- Each fuel limit value multiplied by a combustion plant thermal power, and the product summarize and divided by the total fuel mix of the installations of thermal power amounts.

AIR POLLUTION, FUELS, EMISSION. (VOC) DISTRIBUTION OF PETROL

- The terminal storage infrastructure.
  - Installation floating covers.
  - The outer surface coating with a heat-reflecting material.
- Terminal, mobile tank filling and emptying devices.
  - Hermetic mobile tanks filling.
  - Tanks bottom filling platform installation.
  - Petrol vapor recovery or fragmentation installations.

AIR POLLUTION, FUELS, EMISSION. (VOC) DISTRIBUTION OF PETROL

- Mobile tank

  - Sufficient tightness.

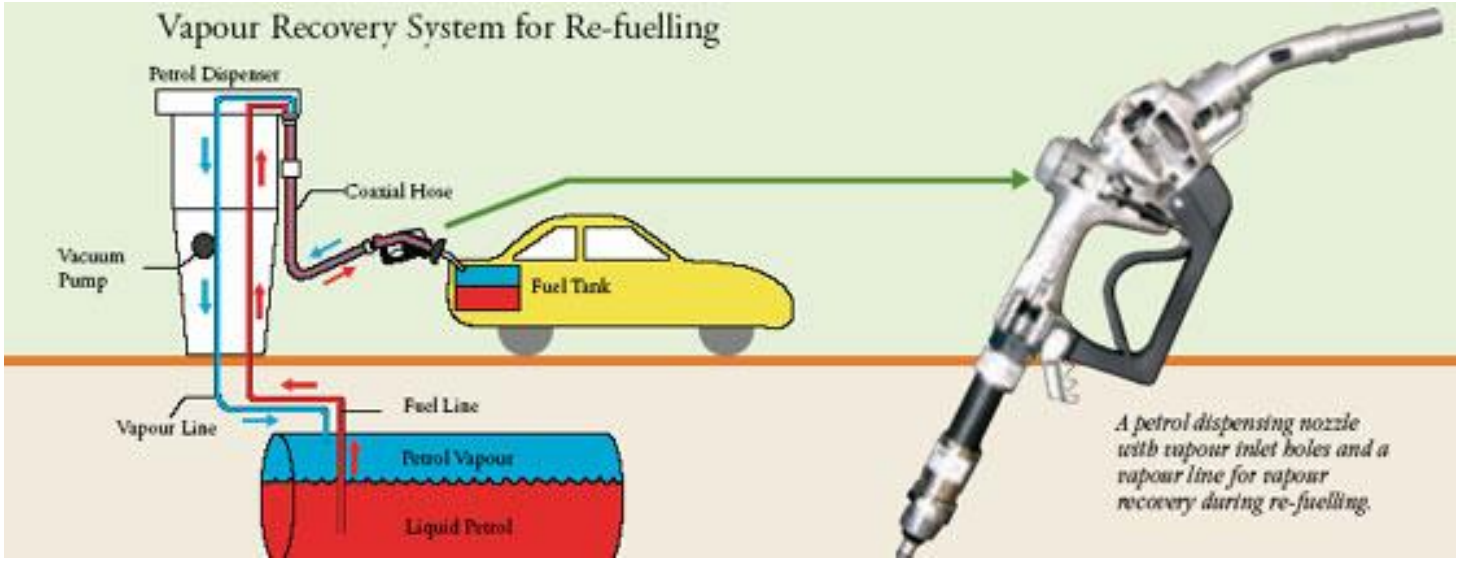
  - The ability to receive steam from the stationary filled container and store them until the next filling.

- Petrol stations

  - Equipped with an efficient gasoline vapor recovery system into the mobile tank.

  - Installed petrol vapor recovery system to the filling station tank, when car tank filling.

AIR POLLUTION, FUELS, EMISSION



http://www.epd.gov.hk/epd/misc/ehk05/english/air/

AIR POLLUTION, FUELS, EMISSION. AIR POLLUTION IN POWER PLANTS

- The generation of electric power produces more pollution than any other industry.
- The energy sources used for production non-renewable resources, fossil fuels such as coal, oil and natural gas.
- Burning fossil fuels changing the planet's climate and harming ecosystems.

AIR POLLUTION, FUELS, EMISSION. AIR POLLUTION IN POWER PLANTS

- Sulfur dioxide emissions contribute to acid rain.
- Nitrous oxides emissions contribute to urban smog.
- Carbon emissions contribute to global climate change.
- Nuclear fuel systems create hazards that may threaten people and the environment.

AIR POLLUTION, FUELS, EMISSION. METHODS FOR CONTROLLING SO2 EMISSIONS

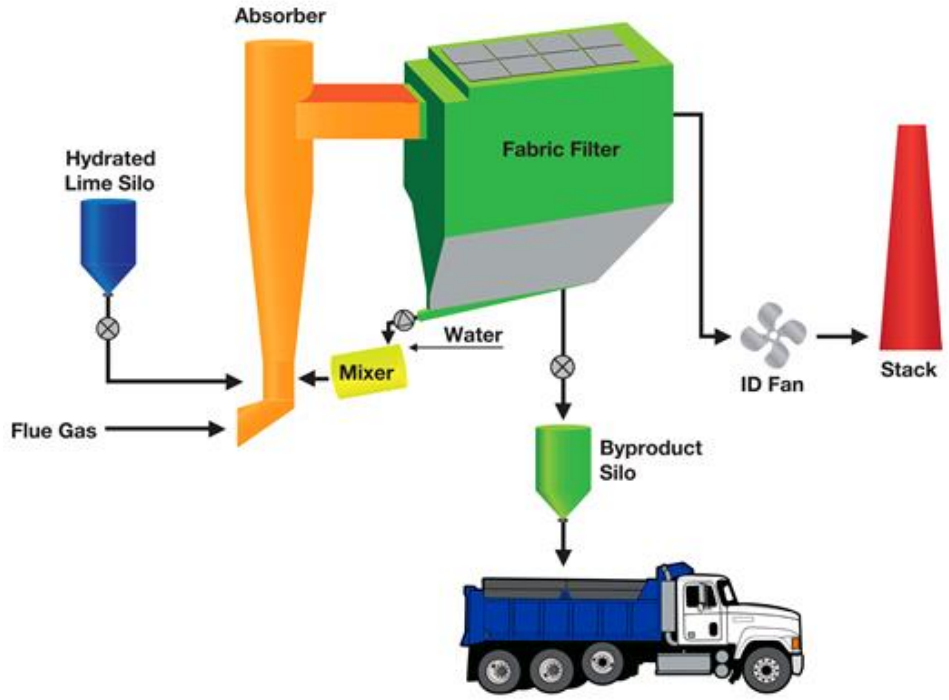
- **Lower Sulfur Fuel** – reduces SO2 formation, May reduce NOx, HCl, and HF emissions.
- **Dry Sorbent Injection –** Captures SO2 at moderate rates. Reagent – Trona, sodium bicarbonate, hydrated lime. Co-benefits – NOx and HCl and HF reduction, Hg reduction, removal of chlorine, a precursor to dioxins/furans.

AIR POLLUTION, FUELS, EMISSION. METHODS FOR CONTROLLING SO2 EMISSIONS

- **Dry Scrubber with Fabric Filter –** Reagent + water react to capture acid gases, dry product captured

  fabric filter. Reagent – Hydrated lime. High SO2 and Hg capture, high PM and HCl capture.
- **Wet Scrubber –** Reagent + water react to capture acid gases. Reagent – Limestone, lime, caustic soda. Highest SO2 capture, high oxidized Hg and high HCl capture, PM capture

AIR POLLUTION, FUELS, EMISSION



http://www.psa.mhps.com/products/environmental_products/ead/

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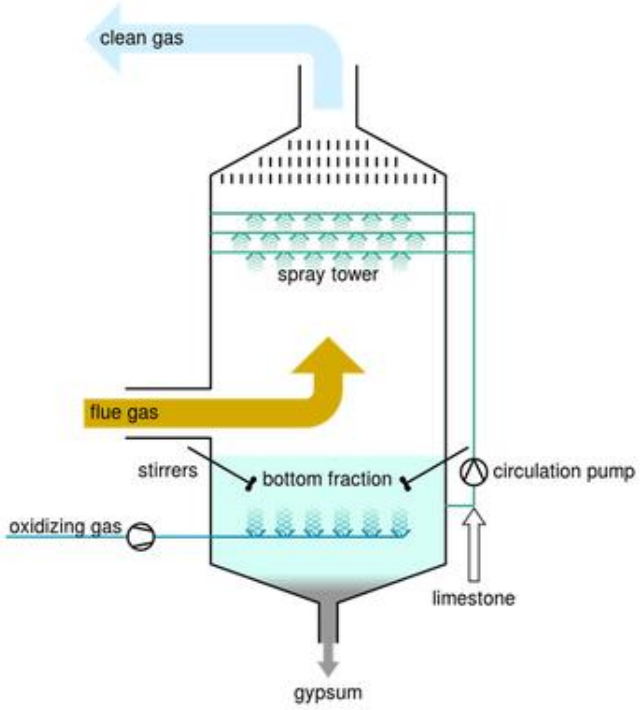
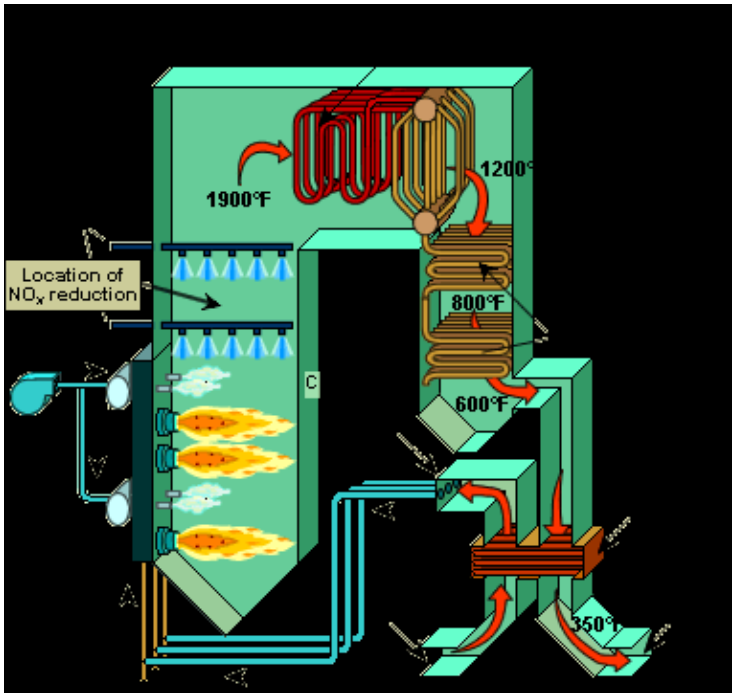


http://energyeducation.ca/encyclopedia/Wet_scrubber

AIR POLLUTION, FUELS, EMISSION. NOx EMISSIONS CONTROL METHODS

- **Combustion Controls** – Reduce NOx formation in the combustion process. Potential impacts on Hg, CO and dioxins/furans.
- **Selective Non-Catalytic Reduction** Reagent injected into furnace reacts with and reduces NOx rates of about 30%. Regent – Urea or ammonia.

AIR POLLUTION, FUELS, EMISSION

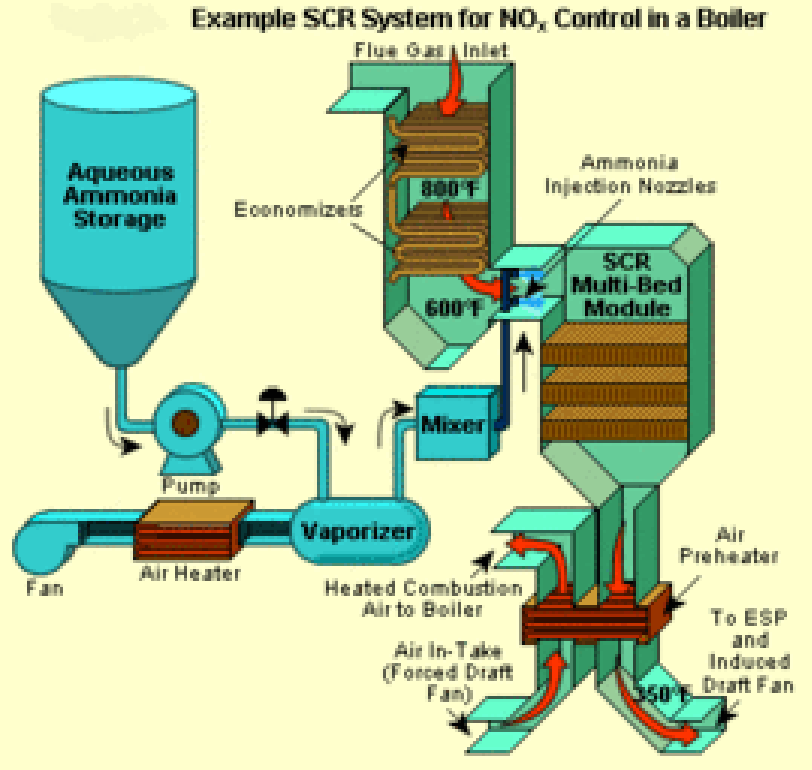


http://www.americancoalcouncil.org/?page=nox

AIR POLLUTION, FUELS, EMISSION. NOx EMISSIONS CONTROL METHODS

- **Selective Catalytic Reduction (SCR) –** Reagent reacts with NOx, across catalyst bed and reduces NOx at 90%. Reagent – ammonia. Co-benefits – Oxidation of Hg for capture in a wet scrubber, reduction of dioxins/furans.
- **Dry Sorbent Injection –** with trona reduce Nox about 10-15%.

AIR POLLUTION, FUELS, EMISSION



http://www.americancoalcouncil.org/?page=nox

AIR POLLUTION, FUELS, EMISSION. CONTROL OF MERCURY EMISSIONS

- **Activated Carbon Injection (ACI) –** Activated carbon adsorbs gaseous Hg, converting to particle Hg that is captured in PM control device. Reagent – Powdered Activated Carbon. Co-benefits – Some capture of dioxins/furans.
- **Halogen Addition –** Halogen (bromine) addition to flue gas increases oxidized Hg that is captured in a scrubber or in PM control device.

AIR POLLUTION, FUELS, EMISSION. CONTROL OF MERCURY EMISSIONS (CO-BENEFIT METHODS OF CONTROL)

- **PM Controls (electrostatic precipitators (ESP), fabric filter (FF), multicyclone) –** Captures particle-bound mercury.
- **Dry Sorbent Injection –** Increases co-benefit and ACI Hg capture by removing SO3, which suppresses mercury capture.

AIR POLLUTION, FUELS, EMISSION. CONTROL OF MERCURY EMISSIONS (CO-BENEFIT METHODS OF CONTROL)

- **Dry Scrubber with Fabric Filter –** Hg captured in fabric filter.
- **Wet Scrubber –** Oxidized mercury captured in wet scrubber.
- **NOx Catalyst –** Catalyst in (SCR) increases oxidation of Hg that is more effectively captured in wet scrubber.

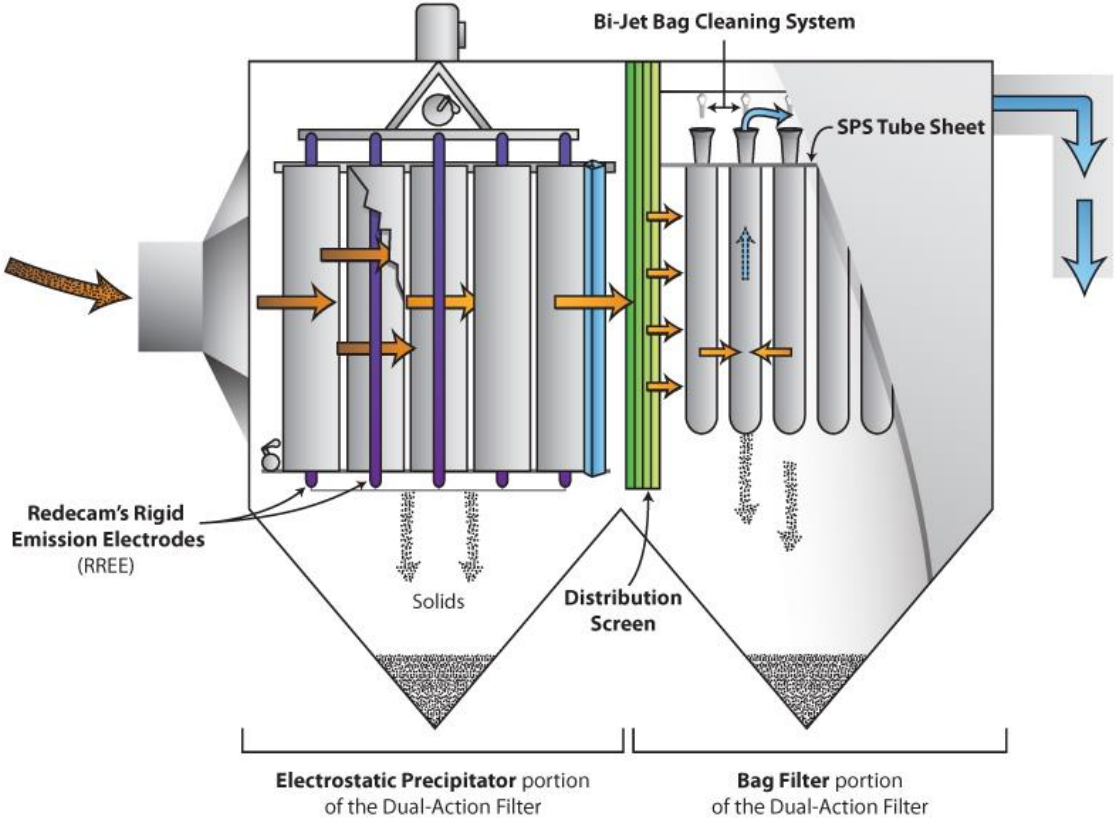
AIR POLLUTION, FUELS, EMISSION. HCL EMISSIONS CONTROL METHODS

- **Dry Sorbent Injection –** dry sorbent captures HCl, downstream PM control device captures dry product. Regent – Trona, sodium bicarbonate, hydrated lime.
- **Dry Scrubber with fabric filter –** Reagent + water react to capture acid gas and dry product captured in fabric filter. Reagent – Hydrated lime.
- **Wet Scrubber –** Reagent + water react to capture acid gas. Reagent – Limestone, lime, caustic soda.

AIR POLLUTION, FUELS, EMISSION. PM EMISSIONS CONTROL METHODS

- **Electrostatic precipitator (ESP) –** Electrostatic capture of PM, high capture efficiency. Co-benefits – Capture particle-bound mercury.
- **Baghouse –** Filtration of PM, highest capture efficiency. Co-benefits – High capture of mercury.
- **Scrubber (wet or dry) –** Captures PM.

AIR POLLUTION, FUELS, EMISSION



http://www.redecam.com/dual-action-filters/

AIR POLLUTION, FUELS, EMISSION. DIOXINS AND FURANS EMISSION CONTROL METHODS

- **Activated Carbon Injection (ACI) –** Activated carbon adsorbs gaseous dioxins/furans, and is captured in downstream PM control device. Reagent – Powdered Activated Carbon. Co-benefits – Capture of Hg.
- **Combustion Controls –** Destruction of organic dioxins/furans.
- **CO or NOx Catalyst –** Catalyst increases oxidation of organic dioxins/furans.

AIR POLLUTION, FUELS, EMISSION

Control Technology	SO2	NOx	(Hg)	HCl	PM	Dioxins
Combustion Controls	N	Y	C	N	N	Y
Selective non-catalytic (SNCR)	N	Y	N	N	N	N
Selective catalytic reduction (SCR)	N	Y	C	N	N	C
Particulate Matter Controls	N	N	C	N	Y	C
Low Sulfur Fuel	Y	C	N	C	N	N
Wet Scrubber	Y	N	C	Y	C	N
Dry Scrubber	Y	N	C	Y	C	N
Dry sorbent injection (DSI)	Y	C	C	Y	N	C
Activated carbon injection (ACI)	N	N	Y	N	N	Y

AIR POLLUTION, FUELS, EMISSION

- N – Technology has little or no emission reduction effect.
- Y – Technology reduces emissions
- C – Technology is normally used for other pollutants, but has a co-benefit emission reduction effect

AIR POLLUTION, FUELS, EMISSION. REFERENCES

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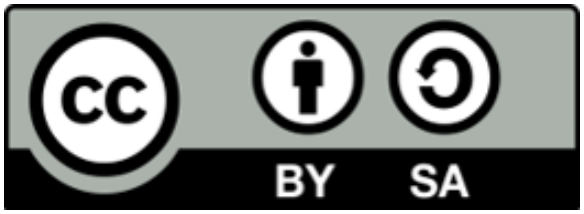
2. Denafas, G. Atmosferos apsauga (Atmosphere protection). 1 ir 2 parts. Kaunas: Technologija, 2000. ISBN 9986137683.



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