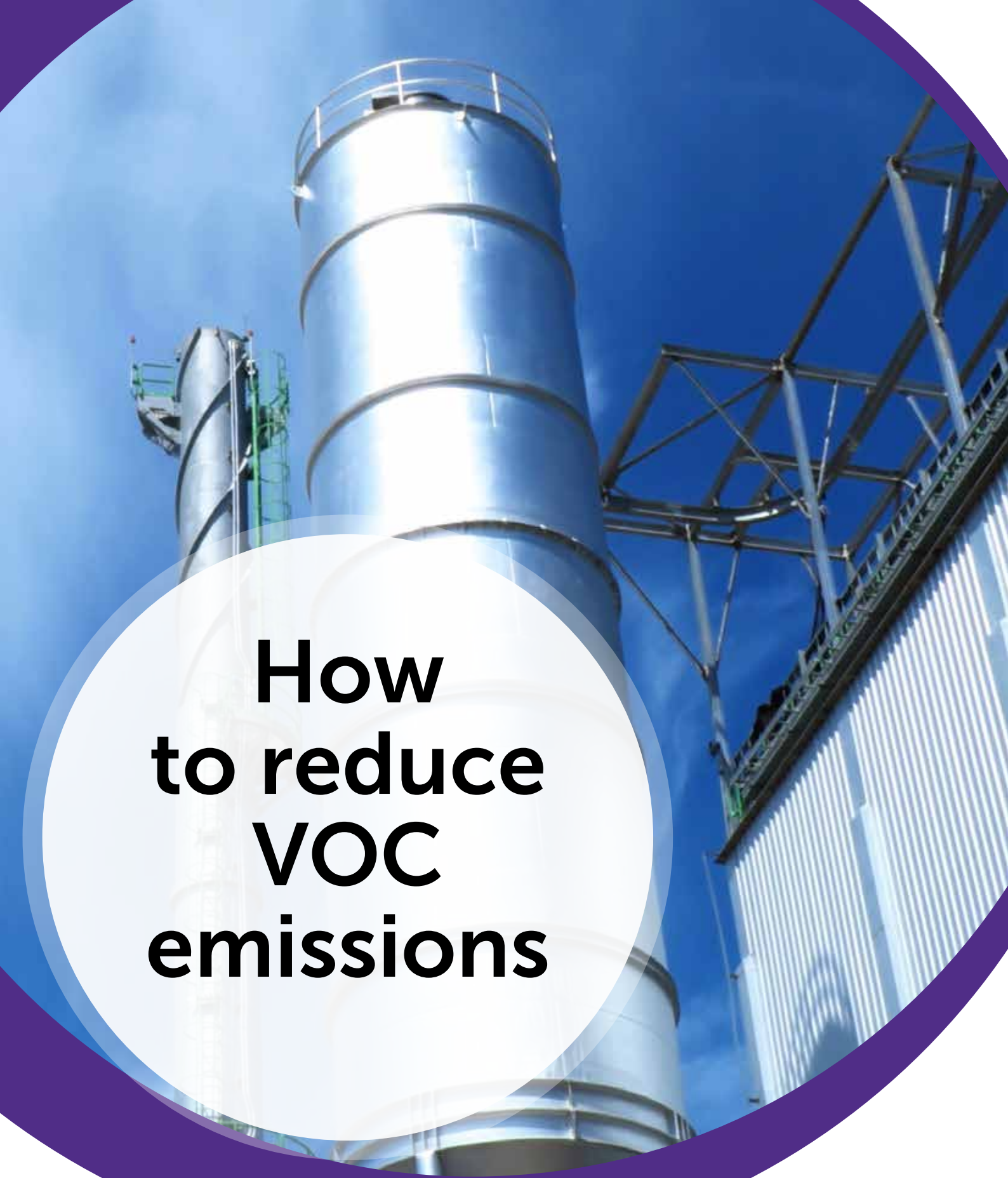


How to reduce VOC emissions

Genano solutions

Prologue

Table of Content

Background, techniques and considerations for VOC abatement

Dear Reader,

New to air pollution control technology? Not sure where to begin? This guidebook gives you a comprehensive view to what are vocs and how do they impact the environment. We take a look at The legislation under The European Union directive for VOC emissions.

As under a heavy legislation, The industries are forced to reduce AIR pollution. Therefore, in this guidebook we have listed a full range of different technologies in use for VOC emission abatement. But how to select a suitable one? In The end of this book, we have collected 10 important criteria for you to consider when comparing technologies and choosing The Most suitable one for your business.

Hopefully this guidebook will give you insight into VOC abatement, and is a good tool for choosing a right solution.

European Union definition of VOC

What are VOCs?

VOCs are a well-known outdoor air pollutant. They are categorized as either methane (CH4) or non-methane (NMVOCs).

The European Union defines a VOC as ”any organic compound having an initial boiling point less than or equal to 250 °C (482 °F) measured at a standard atmospheric pressure of 101.3 kPa.” The VOC Solvents Emissions Directive is the main policy instrument for the reduction of industrial emissions of volatile organic compounds (VOCs) in the European Union. It covers a wide range of solvent using activities, e.g. printing, surface cleaning, vehicle coating, dry cleaning and manufacture of footwear and pharmaceutical products.

Legislation regarding air pollutants

Paris Agreement

The goal of agreement is to keep the increase in global average temperature to well below 2 °C above pre-industrial levels; and to limit the increase to 1.5 °C, since this would substantially reduce the risks and effects of climate change. On October 2018 IPPC published special report on global warming. In the report IPPC says that the target 1.5 °C is possible to achieve but "deep emissions reductions" and "rapid, far-reaching and unprecedented changes in all aspects of society" are necessary.

What is an air pollutant?

An air pollutant is a material that can have adverse effects on humans and the ecosystem. The substance can be solid particles, liquid droplets, or gases. A pollutant can be of natural origin or man-made.

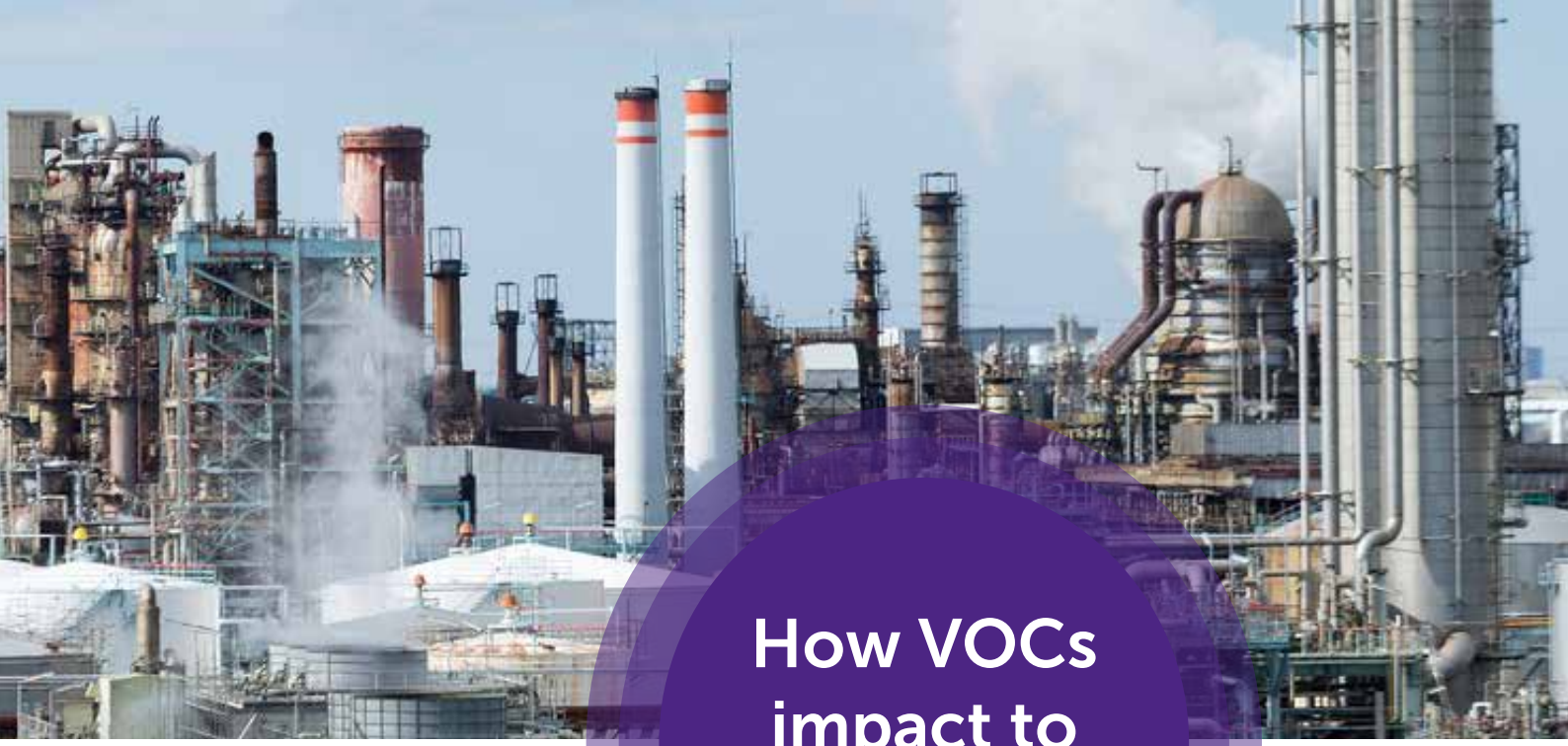
Substances emitted into the atmosphere by human activity include

- Carbon dioxide (CO2)
- Sulfur oxides (SOx)
- Nitrogen oxides (NOx)
- Carbon Monoxide (CO)
- Volatile Organic Compounds (VOC)
- Chlorofluorocarbons (CFC)
- Ammonia
- Odors

EU VOC diretive sets limits for industries

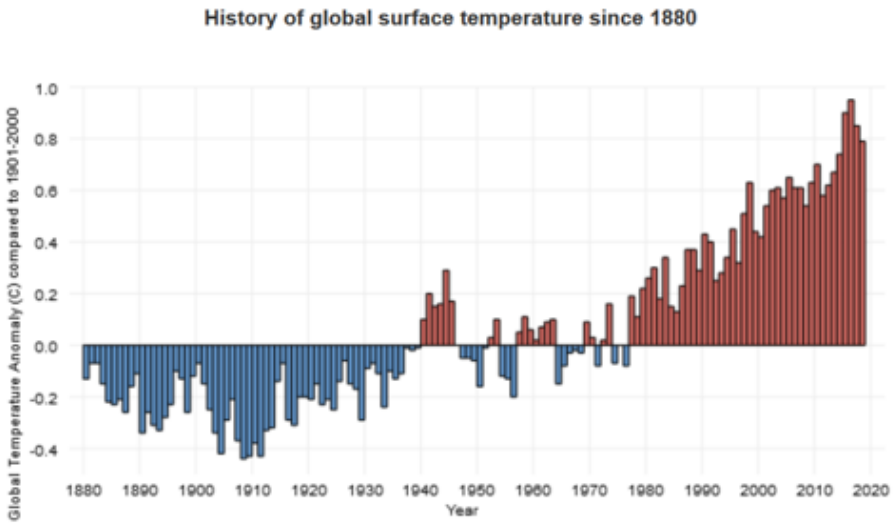
European Union has set a directive (1999/13/EC) for VOC emissions. The purpose of directive is to prevent or reduce the direct and indirect effects of emissions of volatile organic compounds into the environment, mainly into air, and the potential risks to human health. EU VOC directive sets emission limits for different industries including adhesive coating, coating activity, coil coating, dry cleaning, footwear manufacture, manufacturing of coating preparations, varnishes, inks and adhesives, manufacturing of pharmaceutical products, printing, rubber conversion, surface cleaning, vegetable oil and animal fat extraction and vegetable oil refining activities, vehicle refinishing, winding wire coating, wood impregnation, wood and plastic lamination.

Many other countries have set their own legislation for VOC emissions.



How VOCs impact to environment?

Global warming is a long-term rise in the average temperature of the Earth's climate system, an aspect of climate change shown by temperature measurements and by multiple effects of the warming.
According to Intergovernmental Panel on Climate Change (IPCC) "It is extremely likely that human influence has been the dominant cause of the observed warming since the mid-20th century." The main human influence to global warming is the greenhouse gases.
Depending on the rate of greenhouse gas emissions and on climate feedback effects, IPPC has estimated that during the 21st century the global surface temperature will increase 1,8–4,5 °C.



Source: NOAA

Global warming and health risks

Greenhouse gases Contribute to global warming

VOCs are categorized as either methane (CH4) or non-methane (NMVOCs). Methane is an extremely efficient greenhouse gas which contributes to enhanced global warming. Other hydrocarbon VOCs are also significant greenhouse gases because of their role in creating ozone and prolonging the life of methane in the atmosphere. This effect varies depending on local air quality.

Health risk

Respiratory, allergic, or immune effects in infants or children are associated with man-made VOCs and other indoor or outdoor air pollutants. Health effects include eye, nose, and throat irritation; headaches, loss of coordination, nausea; and damage to the liver, kidney, and central nervous system. Some organics can cause cancer in animals; some are suspected or known to cause cancer in humans. Key signs or symptoms associated with exposure to VOCs include conjunctival irritation, nose and throat discomfort, headache, allergic skin reaction, dyspnea, declines in serum cholinesterase levels, nausea, vomiting, nose bleeding, fatigue, dizziness.

VOC abatement technologies

Different possibilities and technologies to reduce VOC emission are available. One possibility is use raw material which VOC content is lower (e.g. water-based paints). However, this isn't always possible and the VOC emission has to be purified with VOC abatement technologies.

Different VOC abatement technologies

1. Oxidation technologies

Thermal oxidation

- VOC gases will be oxidized to CO2 and H20 in high temperature >750 °C
- Regenerative oxidizer consists two or more heat transfer beds which is heated from a previous oxidation cycle to preheat the input gases to partially oxidize them. The preheated gases enter a combustion chamber that is heated by an external fuel source to reach the target oxidation temperature. Thermal efficiency is >90%
- Recuperative oxidizer has a primary and/or secondary heat exchanger

VOC abatement technologies

within the system. A primary heat exchanger preheats the incoming dirty air by recuperating heat from the exiting clean air. This is done by a shell and tube heat exchanger or a plate heat exchanger.

Catalytic oxidation

- Catalytic oxidation is a process where preheated exhaust gas is in contact with a porous catalytic active material. This oxidization method is a fast and flameless combustion.
- Operation temperature >300 °C
- Regenerative and recuperative technologies are possible

2. Adsorption method

- Molecules from exhaust gases are adsorbed to the surface of a solid material.
- The most common adsorption material is activated carbon.
- This method operates in quite low temperatures.

3. Absorption method

Absorption is a diffusion mass transfer operation in which the soluble gas components are separated from the gas stream by dispersing it with the dissolving liquid.

VOC abatement technologies

4. Biofilters

- Biofiltration is a pollution control technique using living material to capture and biologically degrade process pollutants.
- Biofiltration is the simplest and the cheapest biological process to clean volatile organic compounds.
- In a biofiltration process an exhaust gas pretreatment is needed so that the micro-organisms have an optimal environment to operate.

5. Condensation

- In condensation organic compounds are recovered from liquid after the exhaust gases are condensed. Condensation needs either lower temperature or higher vapor pressure until the saturation point of the compounds in the condensation has been reached.

How to choose the right technology

When creating an optimal design for each operation, consider the following 10 variables

1. **Consider your process capacity needs over coming years**
2. **Measure your process air flow (Nm3/h)**
3. **Measure your temperature of inlet gas**
4. **Measure the amount of VOC g/Nm3 (min, average and max)**
5. **Measure the type and percentages of VOCs (e.g. toluene 40% and ethanol 60%)**
6. **Determine emission limit or needed purification efficiency**
7. **Determine process working hours**
8. **Following compounds should be identified and measured from VOCs:**
   - Silicones
   - Chlorides
   - Phosphorus
   - Heavy metals
   - Halogen
   - Sulfur

   These compounds are so called catalyst poisons and it is important to ensure the system is designed to handle the mentioned compounds and particulates.
9. **Consider the installation location at your site**
10. **It is important to calculate total cost for coming years for the right investment decision**
    - Investment cost
    - Operation costs
    - Maintenance costs

Better business with cleaner environment

In conclusion

Clean air requirements have become more regulated and the requirements and legislations will come more stricter in the future. When choosing the right VOC abatement system, it is important to take into account many different aspects such as energy consumption, maintenance and possible business growth.

Modern technologies help us to save energy, shorten the payback time of investment and have cleaner air.

We hope this guide book has been useful to you. Our team is ready to help you to find right solution for your needs.

Our promise to you, our customer:

Trust

built through our understanding of your activities.

Expertise

equals knowledge of air impurities and of ways to remove them.

Ease

offered to our customers by our comprehensive service concept.

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— solutions —

Elektroniikkatie 3
90590 Oulu, Finland
www.genano.com