Effects on the crop, arguments for the use of the Greenhouse GA and application examples

Structure of the document: In this document 3 subjects are explained:

Section 1 – 3:	Explanation of the effects of air quality (NOx - ethene) on the crop and also arguments for the air quality monitoring.
Section 4 – 7	Arguments to use an analyzer for air quality monitoring.
Section 8 – 12	Application examples how air quality savings factors or how an increase in efficiency could be reached in the greenhouse.

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This document explains in a short way which effects there are of pollutants in the air on crops. Advantages of the usefulness of the air quality monitoring are explained as well.
For the effects there will be references to quotes and research literature, which are well known.

In each of the greenhouses were CO_2 is dosed, exists NO_x and Ethylene.
The amount of these gasses determined the yield of how crop responses on it.
The way of how crop responses can be arranged into 3 different situations:

1. Greenhouses immediately have visible damage on crops (estimation: 1-3% greenhouses a year)
2. There are no problems at all. (Estimated on approximately 10% - 20% greenhouses a year)
3. There's something going on, but it isn't immediately visible. (An estimated amount of 80%-90% of the greenhouses are in this category.

By far the most greenhouses have benefits on having the not immediately visible effects been quantified. In the text below we will setting out the benefits:

Theory and practice are closely related to each other. However, the effects on crops, caused by exposure to Ethylene and NO_x, are depending on many different situations, such as:

1. Crop type and cultivar type
2. Crops' age
3. The burdering of the crops and growing conditions (light, nutrition, density, photosynthesis, existence of CO_2, diseases, pests, etc.)

Gathered from investigations is well known that visible effects of exposing crops to NO_x and Ethene, can be categorized into:

NO_x
- Visible damage
- Growth – reduction of biomass, reproduction
- Physiologially – stomatal conductivity, photosynthesis
- Biochemical – enzymaciteit, amount of cholophyll

Ethene
- Necrosis of leaf tissue
- Obsolescence, shedding/fall of blossom and young fruit
- Epinasty, chlorosis, reduction of growth

However, the invisible effect on plants due to exposure to NO_x and Ethene are more difficult to quantify, but are definitely having impact on the plant. One of the most important characteristics, when there's an increase of concentration or exposure of NO_x and Ethene, is an alleged inhibit of biomass production and as a result of that, reduced photosynthesis. Measurable numbers aren't yet been investigated to the last detail. Those described assumptions are a result of the symptoms which are registered, coming from many kind of studies. A part of those are known from A. Dielemans' research. (See quote further on in this document).

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This does mean in practice:

- NO_x (both NO and NO_2) is toxic and causes reduction of growth at higher amount of concentrations, thus causes higher production costs.
- Ethene (C_2H_4) acts as a pro-aging hormone and causes fall/shedding of blossom, colouring of leaf edges and reducing of growth, thus also causes higher production costs.

Estimates about loss of production, caused by reduce of growth - which in turn is related to the deteriorated air quality in greenhouses- , vary between 2% to 10% decreased production. There are known cases where growth of plants such has deteriorated, that no more yield has left anymore.
In these cases, crops seems been damaged in such a way, that little or none possibilities to recover are left anymore. Some reasons are mentioned below, which are substantiated from out investigations for a part, which ultimately will increase the yield of production, will provide an increase of efficiency, reduces the risks and saves energy, all by using a Greenhouse Gas Analyser with which NO_x and Ethene is measuring.

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1. NO_x reduces biomass yield

Reduced biomass yield, quoted from: “CO_2 bij peppers: meerwaarde en beperkingen”, A. Dieleman et al. (Nota 494), The Netherlands.

Met betrekking tot effecten van NO_x kan onderscheid worden gemaakt tussen acute, vaak zichtbare schade als gevolg van een korte blootstelling aan hoge concentraties en chronische schade na een langdurende blootstelling aan relatief lage concentraties. De omvang van chronische schade is meestal onbekend omdat deze vaak niet direct zichtbaar is. Op langere termijn kan het echter leiden tot productieverlies en mindere kwaliteit.

Acute (zichtbare) symptomen als gevolg van blootstelling aan NO treden pas op bij relatief hoge concentraties (>1 ppm) gedurende korte tijd. In kassen is dit vaak het gevolg van een plotseling optredende storing in de installatie (incident). Chronische blootstelling kan negatieve effecten veroorzaken op de fotosynthese en uiteindelijk leiden tot groeireductie. NO_2 concentraties hoger dan 200 ppb kunnen acute en zichtbare beschadiging tot gevolg hebben. De symptomen zijn niet specifiek. Andere luchtverontreinigingscomponenten zoals SO_2, Cl, O_3 maar ook bijvoorbeeld magnesiumgebrek kunnen dezelfde symptomen veroorzaken. Een chronische blootstelling aan NO_2 kan leiden tot niet direct zichtbare symptomen zoals groeireductie, verstoring van de waterhuishouding en verhoogde gevoeligheid voor indirecte effecten (pathogenen, vorst, droogte).

Translated:
“Regarding the impact of NO_x, distinction should be made between immediately visible damage, caused by a short-term exposure to high concentrations, and chronic damage, after a long-term exposure to relatively low concentrations. The extent of chronic damage is usually unknown, since this kind of damage isn’t directly visible. In longer terms, however, this could lead to production losses and lower quality.

Acute (visible) symptoms, as a result of short-term exposure to NO, occurs only at relatively high concentrations (> 1ppm). In greenhouses this is often caused by a sudden malfunction in the system (incident).Chronic exposure could cause adversely effects on photosynthesis and finally will lead to reduced growth. NO_2 concentrations of above 200ppb could lead to acute and visible damaging. Symptoms aren’t specific. Other air pollution components like SO_2, CI, O_3, but also, for instance, deficiency of magnesium can cause the same symptoms. Chronic exposure to NO_2 can lead to symptoms, which wouldn’t immediately be visible, like reduced growth, disruption of water regulation and an increased sensitivity to indirectly affects as for instance pathogens, frost and drought”.

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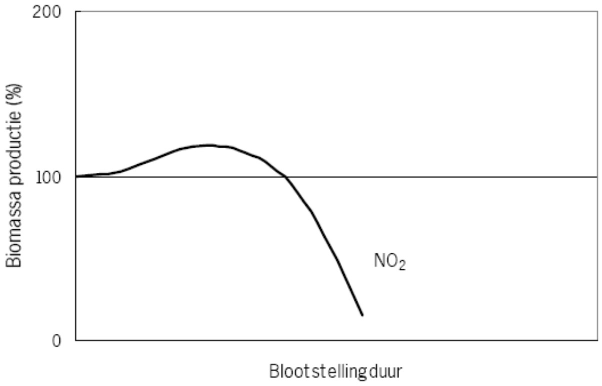
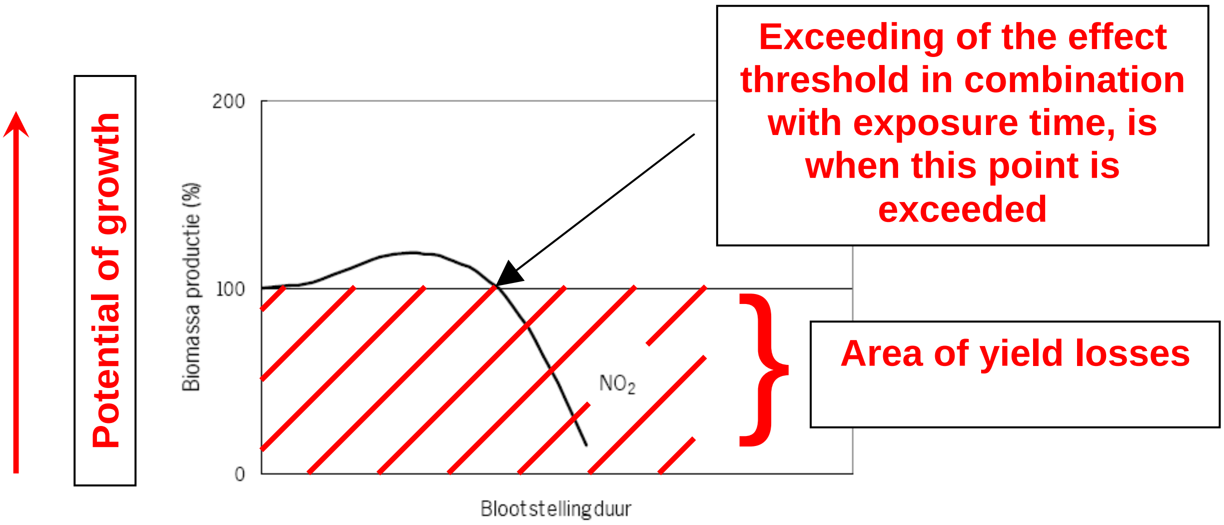


Figuur 6.1. Schematische voorstelling van de biomassa productie in relatie tot de blootstellingsduur aan NO_2.

"Figure 6.1. Schematic representation of the relation between biomass production and the duration of exposure to NO_2" The x-axis describes the exposure time and the y-axis describes the biomass production(%).

To give an rough interpretation, it'll looks like the graph below:



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2. Transpose of biomass reflects to photosynthesis

In the research project “Limits for air quality” attention is paid to the practical side of photosynthesis of Spatiphyllum. A quote from this study is written below:

3.7 Fotosynthesemetingen

De fotosyntheseactiviteit van individuele Spatiphyllum planten tijdens blootstelling aan CO_2 met additionele rookgascomponenten (‘rookgas’) zijn vergeleken met de fotosynthese bij CO_2 zonder additionele rookgascomponenten (‘controle’). Deze metingen zijn lastig om in de kas uit te voeren omdat de CO_2 concentratie in de rookgassen op het niveau van een individueel blad onder die omstandigheden zeer variabel kan zijn. Daarom zijn gasmonsters uit de CO_2-darm genomen en gebruikt als ‘CO_2-bron’ voor de fotosynthesemetingen. De gemeten concentratie aan NOx in de rookgassen was 75 ppb. De huidmondjesgeleidbaarheid was voldoende hoog, waarmee is aangetoond dat de gevolgde methodiek in principe werkt.

Uit de oriënterende metingen blijkt dat de fotosynthese geremd kan worden door rookgassen maar de verschillen in fotosynthese (CO_2 opname) zijn relatief gering (Tabel 10). Bij een lichtintensiteit van 242 µmol m^{-2} s^{-1} PAR werd een gemiddelde afname van de fotosynthese geconstateerd van 4,5%, bij 432 µmol m^{-2} s^{-1} was de afname 0,4%. Verwacht werd dat 75 ppb NO_x een groter effect op de fotosynthese zou hebben, maar er zijn meerdere componenten in rookgassen dan alleen NO_x die hierbij mogelijk een rol spelen. Daarnaast is het zo dat de bladeren bij deze metingen zijn gedurende ca. 10 min blootgesteld aan het rookgas, dat is relatief kort en mogelijk té kort om een significant effect te veroorzaken. Om een effect van rookgassen op de fotosynthese aan te kunnen tonen is het aan te bevelen om de planten voor een langere tijd aan de rookgassen bloot te stellen, conform de praktijksituatie.

Tabel 10. Net fotosynthese van Spatiphyllum bij twee lichtintensiteiten o.i.v. verhoogd CO_2 met en zonder rookgassen. Metingen zijn in drievoud (bij 242 µmol m^{-2} s^{-1}) en tweevoud (bij 432 µmol m^{-2} s^{-1}) uitgevoerd.

Lichtintensiteit (µmol m^{-2} s^{-1})	Controle (µmol CO_2 m^{-2} s^{-1})	Rookgas (µmol CO_2 m^{-2} s^{-1})	Verschil t.o.v. controle
Laag (242)	12.71	11.44	-10%
	11.53	11.73	+1.7%
	11.40	10.79	-5.3%
Gemiddeld			-4.5%
Hoog (432)	13.36	13.58	+1.6%
	13.00	12.68	-2.3%
Gemiddeld			-0.4%

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Translated:

“Measurement of photosynthesis

The activity of photosynthesis of individual Spatiphyllum plants, while exposure to CO_2 with additional flue gas components (“flue gas”), are compared with photosynthesis using CO_2 without additional flue gas components (“check”).This measurements are difficult to perform in greenhouses, because of the concentration of CO_2 in the flue gases on the level of individual leaf in these circumstances could vary a lot. Therefore, CO_2 gas samples used as CO_2-source for photosynthesis were taken from the CO_2-hose .The measured concentration of NO_x in the flue gases was 75ppb. Stomatal conductance was sufficiently high, which includes that the used method basically works.

From the preliminary measurements it shows that photosynthesis can be inhibited by flue gases, but the difference within fotosynthesis (CO_2 absorbing) are relatively low (See table 10).An average decrease of 4,5% photosynthesis was observed with a light intensity of 242m^{-2} s^{-1} PAR and with 432 µmol m^{-2} s^{-1} an decrease of 0,4% was observed. It was expected that an amount of 75ppb NO_x should have a larger impact on photosynthesis, but there are more components in flue gases beside NO_x, which could play a rol in this. In addition, it is true that within these measurements, leaf were exposed to flue gas for ca. 10 min, which was relative short and maybe too short to engender significant impact on leaf. To demonstrate the impact of flue gases on photosynthesis, it is advisable to exposure plants to flue gases for a longer time, according to the practice.

Table 10

Photosynthesis of Spatiphyllum with two light intensities under the influence of increased CO_2, with and without flue gases. Measurements were performed in triplicate (with 242 µmol^{-2} s^{-1}) and duplicate (with 432 µmol^{-2} s^{-1}).

Light intensity (µmol m^{-2} s^{-1})	Check (µmol CO_2 m^{-2} s^{-1})	Flue gases (µmol CO_2 m^{-2} s^{-1})	Difference with respect to check
Low (242)	12.71	11.44	-10%
	11.53	11.73	+1.7%
	11.40	10.79	-5.3%
Average			-4.5%
High (432)	13.36	13.58	+1.6%
	13.00	12.68	-2.3%
Average			-0.4%

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3. Harmfully gases NO_x and Ethene coming from CO_2-dosage causes impact on the crop

Quoted and translated from: “CO2 bij Paprika: meerwaarde en beperkingen A. Dieleman et al. (Nota 494), The Netherlands”.

“*Plants are able to absorb NO_x out of the air, by using their their stomata. Ambient conditions that effects the inlet condition of the stomata are therefore decisive for the repercussion of the plants. There are also indications that absorbing of NO and NO_2 can take place by using the cuticle (Wellburn 1990).From the through the plant absorbed NO and NO_2 (NO_2) nitrate and nitrite is making, which is then enzymatically converted into amino and proteins. The sensitivity of a plant on NO_x is determined by the effectiveness of this transpose. (Detoxification). If NO or NO_2 insufficiently fast should be transposed, it could lead to damage on the plant. The transpose of nitrite into amino acids is associated with the photosynthesis’ reaction on light. This would explain why NO_x is more harmful in darkness (less detoxification) than in the light. Assimilation of low NO_2 concentrations in incorporation into amino acids (Morgan et. al. 1992) shows that nitrogen from out the air contributes to the nitrogen budget in the plant. In other words, low NO_x concentrations would have a stimulating effect on plants, however, rapidly increasing concentrations become more and more toxic and could lead to, inter alia, inhibition of growth (see figure 6.1)”.*

Table 6.2
“Lowest effectively concentration (in ppb) and exposure time whereby NO has caused significantly effects on different kind of plants (from Anon., 2001)”.

Kind	Duration	Concentration (ppb)	Effect/Impact
Growing season			
Mosses	21 days	36	Inhibition of nitrate reduction
Tomato	28 days	407	Inhibition nitrite reduction
Lettuce	16 days	508	Reduction of biomass
Grasses	35 days	407	Reduction of growth
Tomato	80 days	12	Reduction of biomass
Air pollution episodes			
Lettuce	8 days	305	Inhibition of nitrite reduction
Mosses	24 hours	36	Inhibition of nitrate reduction
Paprika	18 hours	1524	Inhibition of nitrite reduction
Houseplants (8 types)	4 days	1016	Inhibition of photosynthesis
Tomato	20 hours	102	Inhibition of photosynthesis
Lettuce	5 days	1016	Reduction of biomass
Short term			
Pea	7 hours	153	Higher generation of ethylene
Tomato	3 hours	407	Inhibition of nitrite reduction
Corn	1 hour	610	Inhibition of photosynthesis
Lettuce	10 min	2033	Inhibition of photosynthesis

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Tomato	2 hours	102	Inhibition of photosynthesis

Table 6.6
"Overview of how NO and ethylene effects on paprika, with associated exposure values. From: Anon., 2001 and Beaudry & Kays, 1988)"

Component	Effect parameter	Concentration (ppb)	Exposure time (hours)	Inhibition (%)
NO (Nitric Oxide)	Nitrite reductase	1524	18	Inhibition
	Abscission of flower bud	10	120	54
		100	120	81
		1000	120	100
	Abscission of products	10	120	90
		100	120	90
		1000	120	100
	Abscission of leaf	10	120	None
		100	120	None
		1000	120	22

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4. Too much NO_x usually leads to excessive ventilation, resulting into higher energy losses

An excess of NO_x and Ethylene in the greenhouse necessitates to progressively ventilate. Less NO_x and Ethylene out of the CHP (Combined Heat & Power) or gas burner reduces the (needed) amount of ventilation. It is important to know that NO_x / Ethylene concentrations at plant level, coming from the CHP / gas burner are well known, because of the fact that reduction of NO_x and Ethylene by, for instance, adjusting the equipment, CHP / gas burner, leads to lower (needed) amount of ventilation and therefore will lead to less energy losses. Dosing CO_2 have to be done on the most effective times a day (Light and photosynthesis activity). NO_x irrevocable comes along with dosing CO_2 and needs to be brought outside of the greenhouse by ventilation. Ventilation of with NO_x polluted air costs unnecessary energy (like heat and moisture). Therefore it’s very important to have insight in how much and when ventilating shall start, because of the high amount of NO_x concentrations in the greenhouse.

The CO_2 sources’ quality determines everything: If it burns more cleanly, the less ventilations is needed to keep the air quality sufficiently clean. Because of that it is possible to have 25% les heating losses in the early spring, if there’s 25% cleaner gas burning. This ratio is proven at different paprika farms, with both cold weather as with very sunny weather.

This is made demonstrably clear by EMS and Green Formula within the “Greenhouse air pollution Agriport A7” project[1]. This project is done at three paprika farms from Agriport A7 and is accompanied by Syntens and a part of it subsidized by “KansenKanon Noord-Holland”. All measured data from these companies is modelled in such a way that complexly relations between NO_x, position of the window / amount of ventilation, temperature of the heating pipes in the greenhouse and costs become more insightful.

[1] Agriport A7 is located above Amsterdam, at the top of the province “Noord Holland”, near the A7 highway.

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5. NO_x and Ethylene monitoring prevent damage

In the earlier past it was possible to insure against crop damage. However, the risk of crop damage won't be found in the damage itself, but at the end of the chain at the point if the insurance would reimburse the injury or not. Therefore, out of the entrepreneurship it would be more important to start at the begin of the chain. Monitoring NO_x and Ethylene in greenhouses gives a clear insight into the quality of air. According to this, data measures could be taken and risks for growers would therefore be lowered. Risks that could be very high looking at medium to large companies.
NO_x and Ethynlene shall be monitored continuously, because of the risk that somewhere in the periphery or CO_2 dosing installation defects could occur, or in winter accumulation occurs caused by lower position of the aeration windows. By the fact of that concentrations could reach very high or gone exceeding over the effect limits.

The risk of NOx and Ethylene can be approximately expressed as:

Risk = Time * Concentration

One can broadly say that the risk will increase when:

- CO_2 concentration (thus) Etheen and NO_x will increase
- Exposure time of Etheen and NO_x will be lengthen

Moreover, there will be higher risk when:

- The crop gets more exposed to light (so, CO_2 fertilized)
- The crop gets more to endure
- There's less or no ventilation
- Technical installations (like CHP) doesn't get regularly maintained
- There's no frequently monitoring or controlling

6. CO_2's source (CHP/Gas boiler) can influence decisions about CO_2 dosing

By knowing the association between CO_2 sources, one could choose which of the strategies is best. Ultimately, the source with the lowest emission sometimes is the best and deliver the most, keeping in mind the issues as energy, CO_2 demand, light and other conditions.

7. Measuring at plant level instead of device level

A common heard argument is that CHP / flue gas cleaners are monitored by equipment which measures concentrations and showing those to the grower. That's completely true, however, this equipment controls the CHP / Flue gas cleaners. The Greenhouse Gas Analyser measures concentrations on crop levels. This is a totally different look at the concentrations and is necessary. Ventilation levels may not always be implemented as a hard parameter.

Further on there's an unanswered question: What kind of equipment controls the gas boiler, if only the CHP is controlled?

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8. Application note: less waste of pure (liquid) CO2 / OCAP CO2

One of the biggest opportunities to reduce costs, by using a Greenhouse Gas Analyser, is by controlling the windows in combination with the choice for the pure (liquid or OCAP) CO_2 source and in combination with the CO_2 boiler or CO_2 CHP. NO_x is a very well parameter to measure the air quality. A higher amount of NO_x requires ventilation of the greenhouse. Wide open aeration windows results in higher costs caused of the higher amount of energy – relative expensive pure CO_2 – losses. However, with wider ventilation gaps of the aeration windows, a less pure CO_2 source may be used, because of the NO_x can blow out of the greenhouse more easily, since the aeration windows already are still open!

One method to control this in a good manner, is coupling the position of the aeration window (0-100%) proportional to the concentration of NO_x. The aeration window thereafter will be coupled via a proportional pure CO_2 dosing valve and with the proportional CO_2 dosing valve of the CHP.
By turning the CO_2 dosing valve more open with smaller aeration window gaps and by turning the CHP's dosing valve to a more closed position, as a result more pure CO_2 will be used in the greenhouse without leaking away immediately.

Conversely, with bigger aeration window gaps, the dosing valve of the pure CO_2 may be closed as far as possible and the CHP's dosing valve may be more opened. The graph below sketches the controlling system. An important note is that NO_x concentrations below the 40 ppb level within 24 hours are in principle allowed. In fact, by transposing NO to nitrogen components, this will act as an growth catalyst (see also chapter 1). This is in principle also the reason why CO_2 from flue gases not particularly are a bad thing, providing that the concentration levels are acceptable.

A summary of the advantages:

- The NO_x concentration is optimal, delivering a maximized photosynthesis and a minimizing of adversary effects on the plants. This provides a maximum of prevention against reduction of growth.
- NO_x is admitted for a level of 40ppb, so the NO_x may be used as growth catalyst for the crop and delivers the maximum of biomass transpose.
- The pure CO_2 will be used in the most efficiently way, lowering the cost of pure CO_2 by that.
- The relatively cheap CO_2 of the CHP is used as much as possible.

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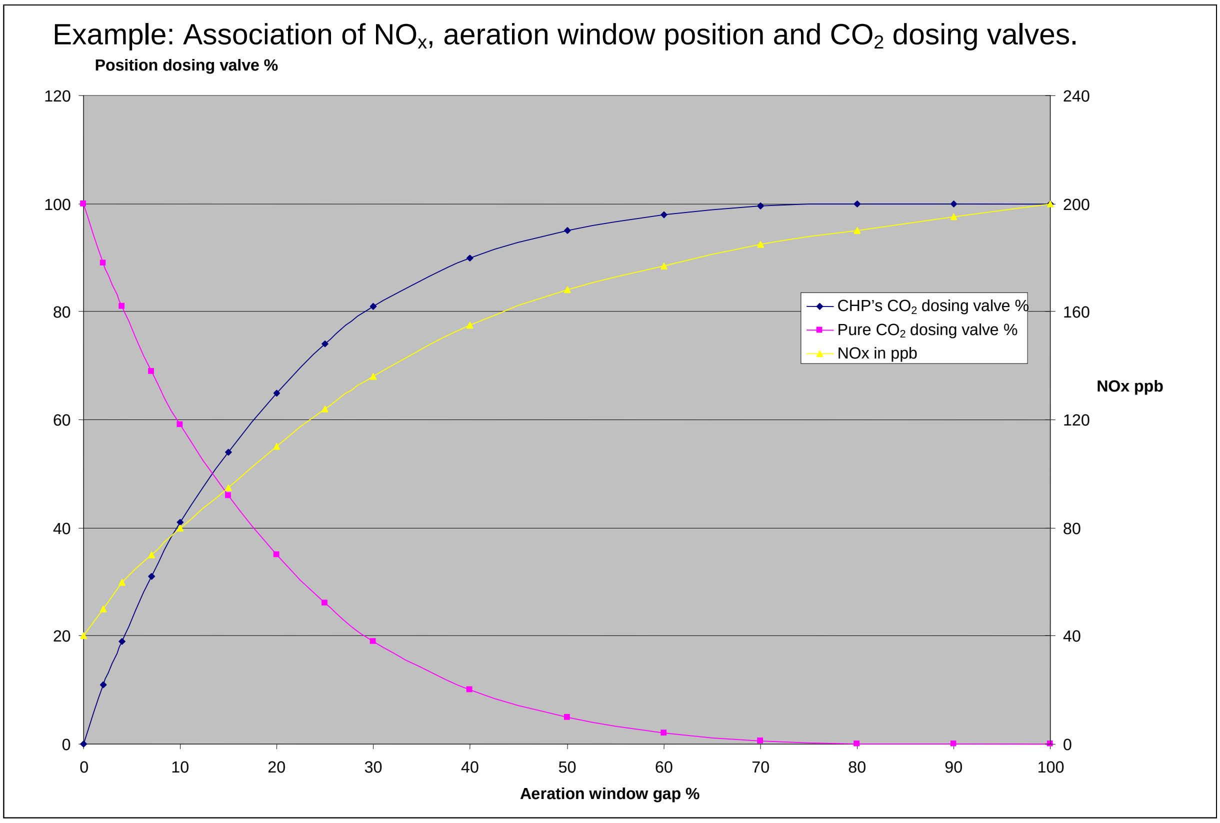

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9. Application note: Controlling window positions in spring – summer – autumn

In a heat-overproduction period, it is useful to prevent accumulation of NO_x by opening the aeration windows. The times of window opening and closing can be very important. It is advisable not to bring in CO_2 from the CHP, just a moment before window will be closed for night. When there's around time of closing the windows a surplus of heat in the greenhouse, it is very important to dose CO_2 and then venting the greenhouse, to prevent accumulation of NO_x. This applies to all moments of dosing CO_2. Off course, opening of aeration windows is limited. In wintertime, and therefore a combination of lack of heat, it could be necessary to let increase the NO_x concentration a little, with accepting higher concentrations.

<u>In summary, the advantages are:</u>

- In any case, the NO_x concentration will be limited to a certain set point, with a maximum reduction of the aeration window gap, instead of a best possible window position.
- Negative effects to photosynthesis shall therefore be limited already and negative effects on plants will be minimized within the capabilities. This results in prevention of inhibition of growth.
- NO_x is admitted to a value of 40ppb, by which the benefits of NO_x could be used as a growth catalyst. This will ensure a maximum of biomass transpose.
- Relatively cheap CO_2 of CHP and/or gas boiler could be used as much as possible.

10. Application note: Choosing your CO_2 source based on NO_x emissions / Ethylene

It's often asked: What shall be better, CHP's CO_2 or the Gas Boilers' O_2? There's no clear answer for that, because of it'll be dependent on the situation. By comparing the analysers' and climate computers' data it is possible to give a better answer which CO_2 source is the cleanest. Thereby it's also possible to monitor the curve of source quality in time. For this purpose, the climate computers' data will be near-time analysed as substation for ongoing decisions and given back to the user.
As example it is possible that there will be an outcome that (for instance) the gas boiler is 2.38 times cleaner as the CHP. His is useful to choose the right source. In particular, during winter where the heat demand usually is high and therefore NO_x concentrations are high, it can be very needed to choose the cleanest source. A connection between the climate computer and additional analyse software is required. Please, ask EMS for more information.

In summary, the advantages are:

- Ethylene and NO_x accumulation are going to reduced by choosing the right CO_2 source
- At times where accumulation is high, the speed of the accumulation will be reduced, allowing a significantly reduce of concentrations in the greenhouse.
- Analysis of Ethylene and NO_x per source will give the required information about potentially deterioration of used equipment (as boiler(s), CHP, RGR) with respect to time.
  This will be, for instance, shown as emission of ethylene, NO_x a hour per source.

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11. Application note: Risk control on maximum concentrations versus time

Basically, it isn't that bad if limits of ethylene or NO_x concentrations are exceeded, provided that the higher concentration is compensated with lower concentrations in the past or in future. It is therefore necessary that average concentrations will be maintained. A Climate Computer is the perfect machine to calculate cumulative concentrations and to measure the concentrations' gradient. By monitoring this risk limits and compare those monitored values with the allowed concentrations, the user is be able to get insight in how far the values differs from the risk limits. And with that the user is been able to decide whether or not adjustments, manually or automatically, are needed. Especially for excesses, like during winter, this can be very useful. When aeration windows are frozen and therefore accumulation of NO_x and Ethylene occurs, it wouldn't be advisable to stay dosing CO_2 , whatever it takes. Monitoring of the risk limits makes this more clear.

<u>In summary, this are the advantages:</u>

- Risk of excessive levels of NO_x and Ethylene will be clarified
- By monitoring, users are be able to prevent damage
- A less of air quality can be compensated with periods with better air quality. By this, ad-hoc controlling can be prevented and will monitor the average behaviour of which is desired for greenhouses

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12. Application note: Dosing ethylene acting as Biocide

The use of Ethefon and Etherel are reduced further and further on. There will be a time that these remedies wouldn't be allowed anymore. Nowadays, these remedies are only used in tomatoes and no longer in peppers anymore. Dosing of gaseous ethylene via the CO_2 dosing tubes, will give the same result as those remedies and perhaps much a better result. There are many additional advantages. This is proven at the end of the growth, but using this for the regular crop is currently being investigated further on.

Ethylene has impact on crop, but also on the young fruit. The young fruit needs to be ripening. The crop and its leaf needs be stay with minimized damage. The longer the leaf stay in perfect condition, the more sugar production will keep on (Photosynthesis and biomass transposes). Leaf suffers, when ethylene and light are presented together at the crop. By that, moisture supplies are cut off, which results in dying leaf. By taking away light or ethylene, this negative results will been prevented. Stomata of leave are closed at night and by that, ethylene has less impact on crop. At the other hand, the young fruit stays absorbing ethylene at night. Therefore, dosing of ethylene only will take place at night.

<u>In summary the advantages are:</u>

- Ethylene is a natural gas, with no danger for public health (Green alternative).
- Ethylene is controllable. By dosing ethylene at night and ventilate at sunrise, the crop will be saved and young fruit will still ripe at night.
- Due to lower set points, ethylene dosing in regular crop is became a possibility.
- Not a wait of 7 days before the harvest, but a more gently way of harvest.
- Energy saving

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