COdiNOx

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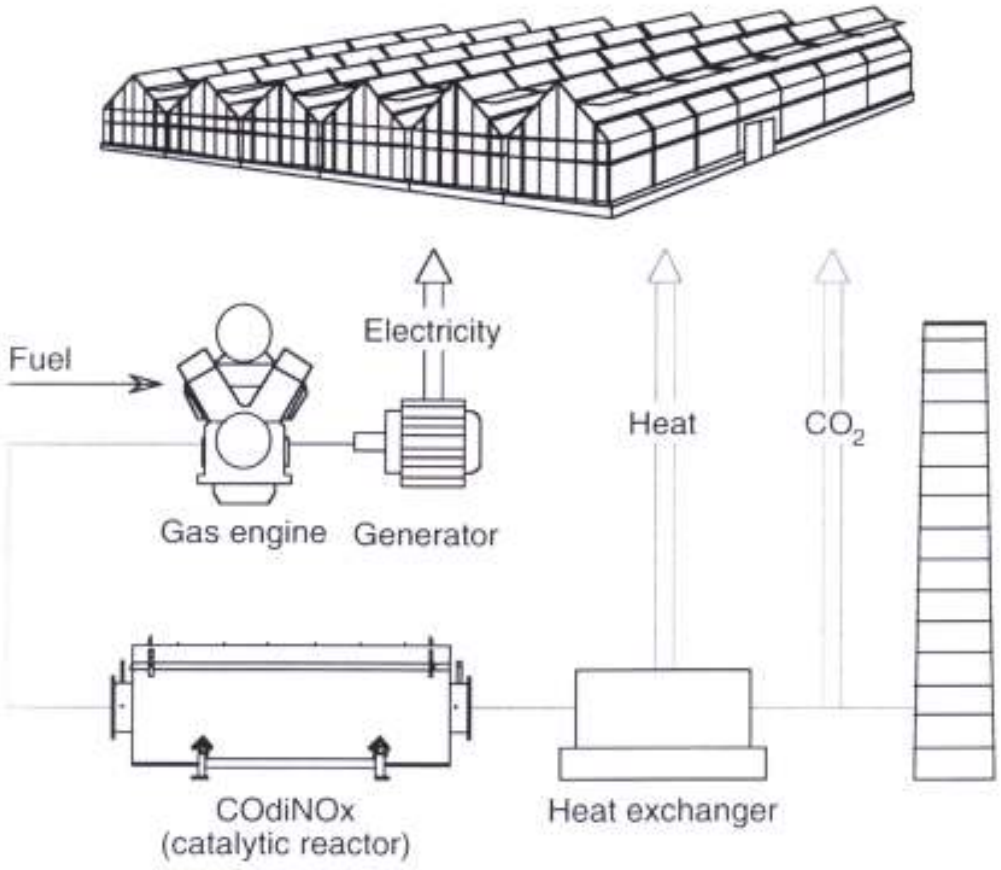
Greenhouse manuring with CO_2 derived from engine exhaust gases



Exhaust Gas Purification Systems

COdiNOx

By raising the content of CO_2 in the atmosphere in greenhouses, productivity can be increased by up to 30%.
COdiNOx systems offer the greatest operating economies and permit optimum control of production conditions.

The exhaust gas from lean-burn gas engines is purified by our **COdiNOx system** resulting in gases which are present in our natural atmosphere. At the same time, the carbon dioxide (**CO_2**) content is increased from the natural level of 350 ppm to about 800 ppm.

By the complete utilisation of the amount of fuel used, in addition to the heat and current generated, the CO_2 in the exhaust gas can also be used economically in greenhouses.

In this manner about 10,000 sq. metres of flowers can be gassed with CO_2 by using 35 cu. metres of fuel gas (natural gas) per hour, while 10,000 sq. metres of vegetables can be gassed by using 60 cu. metres per hour.

Photosynthesis in green leaves of plants results in carbon dioxide (CO_2) being absorbed and converted into carbohydrates. This is equivalent to growth.

The combustion of fuel gas in gas engines produces the fertilising gas carbon dioxide (CO_2). In order to make use of this CO_2 again in greenhouses, so-called "**CO_2 cannons**" are used which release carbon dioxide (CO_2) as a result of combustion. At the same time - and in contrast to having subsequent **COdiNOx system** treatment - heat is generated by the combustion activity causing the temperature in the greenhouse to rise, which is to the detriment of the plants so that the greenhouses need to be ventilated to dispose of the surplus heat. The discharge of the surplus heat is accompanied by the escape of the carbon dioxide CO_2.

The combustion of fossil fuels results in the production of the harmful gases nitrogen oxides, carbon monoxide and unburned hydrocarbons. The nitrogen oxides and carbon monoxide together with ethylene are subject to special exhaust gas regulations.

Systems for purification of exhaust gases from engines running on natural gas (normally in lean-burn conditions) have been in operation since the summer of 1993. When the concentration of harmful gases is too high, these systems stop feeding the CO_2 into the greenhouse and automatically direct the exhaust gases into the chimney stack.

The most important point relating to the improvement of air quality is that the emissions must be monitored. Operation with a badly installed system results in the injection of CO_2 into the greenhouse being shut off. If a **CO_2 cannon** system does not run under optimum conditions, this cannot be detected in the area close to the cannon. This means that higher concentrations of harmful gases can only be detected when these higher concentrations arise in the greenhouse itself and are already destroying the products growing there.

By the use of gas engines with **COdiNOx systems** instead of CO_2 burners, better conditions for personnel working in the greenhouse will be achieved in addition to an improvement of the ambient conditions for the plants. The quality of the gas stream is monitored before it passes into the greenhouse and the appropriate value limits are not exceeded.

The exhaust gases from the engine pass into the catalytic reactor. In the reactant injection unit, a metered volume of a solution of urea in water is injected through a spray nozzle powered with compressed air. This is vaporised within a precisely defined section of the reactor and is partially converted into ammonia. After this, homogeneous mixing of the exhaust gas and the reactant takes place in the mixing section. The exhaust gas then passes into the forechamber of the reactor where it is uniformly distributed as it travels through the catalytic reactors where SCR and oxidation stage units are arranged in that sequence in the shell of the reactor.

Photosynthesis: $6\,CO_2 + 6\,H_2O = C_6H_{12}O_6 + 6\,O_2$

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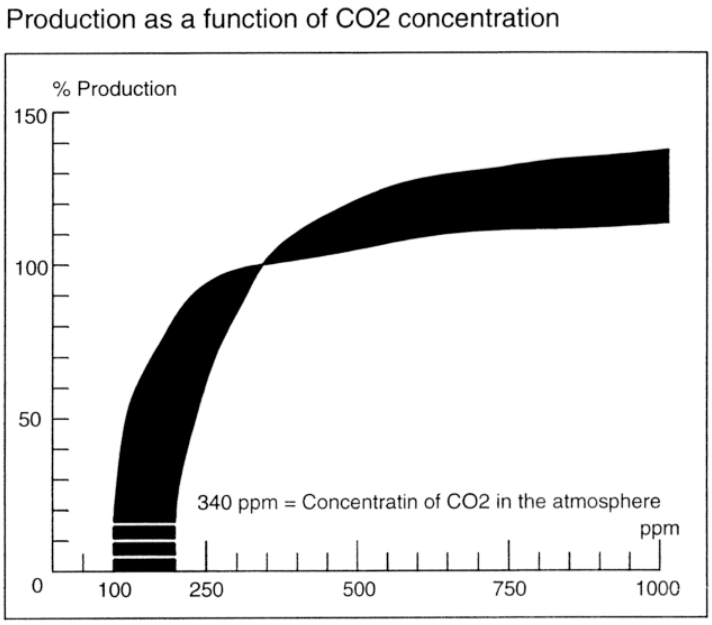
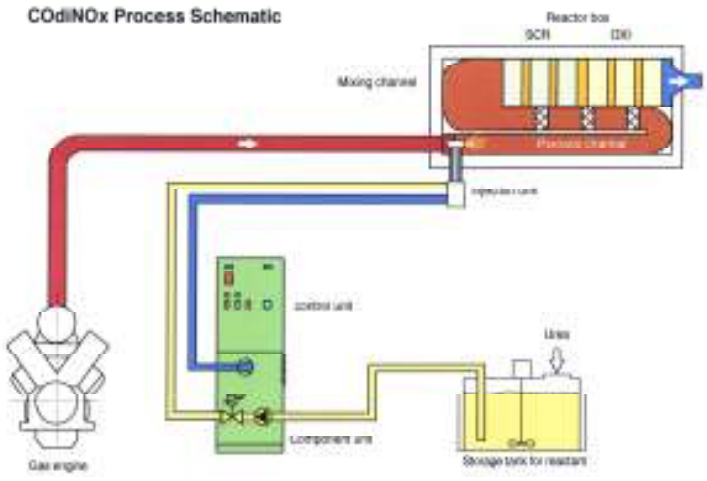
HUG Engineering works almost exclusively with urea as the reactant material. Although ammonia has been used for about 2 decades as the reactant for the reduction of nitrogen oxide levels in exhaust gases containing oxygen, from 1986 HUG Engineering has pioneered the development of the urea process for use with engine exhaust gases. As a solid compound soluble in water, urea offers considerable advantages over ammonia in terms of transport, storage and handling procedures. Urea is not subject to the dangerous substances regulations, is not poisonous and can be used without any special protective measures. Moreover, it is cheaper to use urea than ammonia for the reduction of nitrogen oxides.

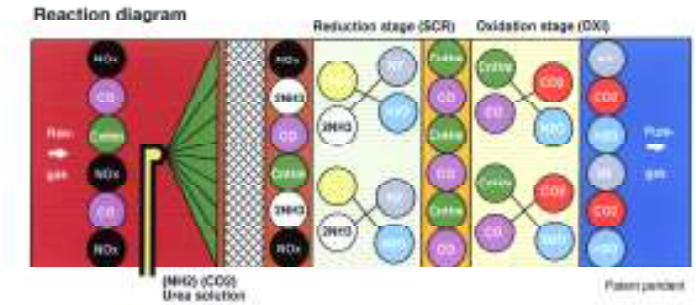
The nitrogen oxides (**NO_x**) are reduced by the SCR-process (**S**elective **C**atalytic **R**eduction). The exhaust gas containing the reactant urea flows through fine-celled honeycomb-shaped catalytic bodies. There the nitrogen oxides react with the reactant on the active surface of the catalyst and are thereby reduced to water (H_2O) and Nitrogen (N_2).

In the same way as for the NO_x emissions, emissions of CO and C_nH_m are also monitored by the **COdiNOx system**. In order to reduce the amounts of carbon monoxide and hydrocarbons, an oxidation stage follows the **COdiNOX system** unit for the reduction of the nitrogen oxides. This catalytic reactor operates with conversion rates of almost 100%. In the catalyst-coated ceramic honeycombs, the harmful gases diffuse through to the surfaces and react there into steam and the fertiliser carbon dioxide (CO_2).

In this respect also, the **COdiNOx system** is far superior to that of the **CO_2 cannons**.







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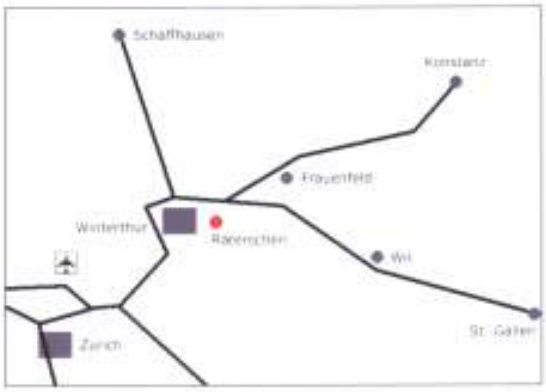

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