VocsiBox® - Filling a gap …

Landfill Gas Oxidation System for low calorific value

VocsiBox®, The Solution

(VOCs - Volatile Organic Compounds)

Based on the speech of:

Wolfgang H. Stachowitz, Dipl. Ing.

held on 13/12/2000 at the UK Launch of the VocsiBox®

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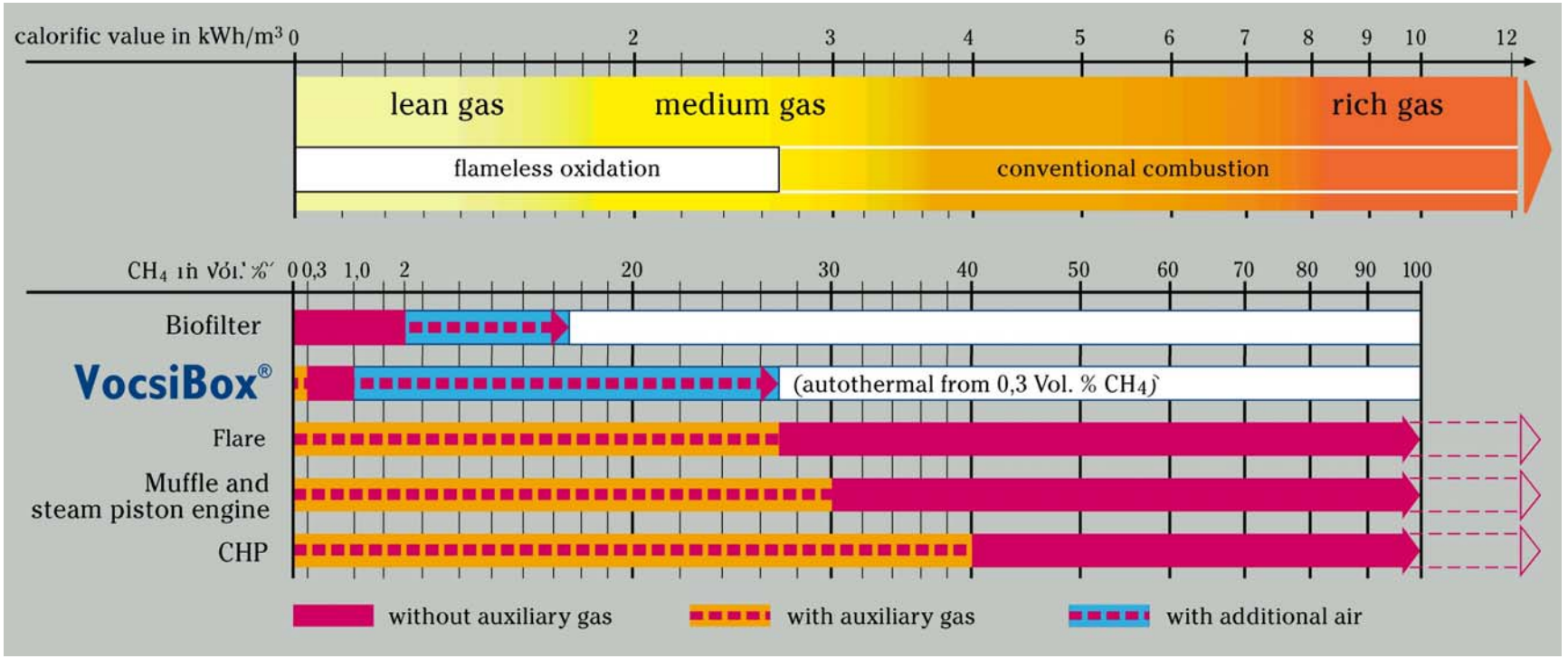
Area of operation:



5 % Vol. < Ex-limits on methane < 15 % Vol.

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VocsiBox®

Advantages of reducing the greenhouse effect by minimising the global CO_2 emissions

The main advantage of the VocsiBox® compared to a biofilter plant is that the methane extracted from a landfill and its accompanying gas (which is partially toxic) are completely oxidised. The greenhouse effect is considerably reduced since the VocsiBox® technology is a combustion – whereas the effect of the biofilter technology is mainly deodorising. A biofilter plant discharges the odourless methane directly into the atmosphere. However, since the contribution of methane to the greenhouse effect is approx. 20 – 25 times higher than the respective value of CO_2 the VocsiBox® technology is state-of-the-art for old landfill sites. Compared to the biofilter, the reduction of greenhouse gas is approx. 90 %.

Example for the reduction of CO_2 and the costs involved:

Landfill gas volume: 150 Nm³/h, 22 % Vol. CH_4

CO_2 emission biofilter: 51,684 t/a (calculated as equivalent to CH_4)

CO_2 emission VocsiBox® : 5,676 t/a

CO_2 emission reduced by approx. 46,000 t/a = 90 %

Investment per reduced ton of CO_2 emission = Euro 10 - 15.- /t calculated on the basis of 10 years operation.

Considering the Agreement of Kyoto and Den Haag, we feel that this procedure for reducing the greenhouse effect will easily sell on the world market.

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Estimate of the emission reducing effect (CO_2 balance) of biofilter compared to VocsiBox®

Extracted landfill gas: 150 Nm³/h

methane contents: 22 % Vol.

Calculation of the untreated CH_4 and the equivalent CO_2 emission:

Density CH_4: $\frac{16\,g}{22{,}4\,l} = 714$ g/Nm³

Mass flow rate CH_4: m_{CH4} = 150 Nm³/h x 0.714 kg/Nm³ x 0.22 = 23.6 kg/h

CH_4 oxidation $CH_4 + 2O_2 = CO_2 + 2H_2O$

Density CO_2: $\frac{44\,g}{22{,}4\,l} = 1.964$ g/Nm³

Ratio: $\frac{CO_2}{CH_4} = \frac{1.964\ g\ /\ Nm^3}{714\ g\ /\ Nm^3} = 2{,}75$

Mass flow rate CO_2: $m_{CO2} = m_{CH4}$ x $\frac{1.964\,g/Nm^3}{714\,g/Nm^3}$ = 23.6 kg/h x 2.75 = 64.8 kg/h

The influence on the greenhouse effect depends on carbon dioxide and methane.

Based on a global warming potential of CO_2 = 1.

Global warming potential of CH_4 compared to CO_2 = 20 - 30[*1] (selected: factor 25)

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Carbon dioxide emission referring to biofilter technology:

Conditions:

- No CH_4-degradation (based on measured data)
- Global warming potential of CH_4 compared to CO_2 = factor 25

$m_{CO2} = m_{CH4} \times F = 23.6$ kg/h x 25 = 590 kg/h

m_{CO2} (based on 10 years) = 590 kg/h x 8.760 h/a x 10a = 51,684 tons/10 a

Carbon dioxide emission referring to flameless, non catalytic oxidation (VocsiBox®):

Conditions:

- complete transformation of CH_4 into CO_2

m_{CO2} = 64.8 kg/h

m_{CO2} (based on 10 years) = 64.8 kg/h x 8.760 h/a x 10a = 5,676 tons/10 a

Reduction of the CO_2 emission:

Biofilter	m_{CO2} =	51,684	tons/10 a
VocsiBox®	- m_{CO2} =	5,676	tons/10 a
Reduction	m_{CO2} =	46,008	tons/10 a

- The CO_2-emission is reduced by approx. 90 %!

[*1] Bouwmann, A.F : Land Use Related Sources of CH_4 and NO_2

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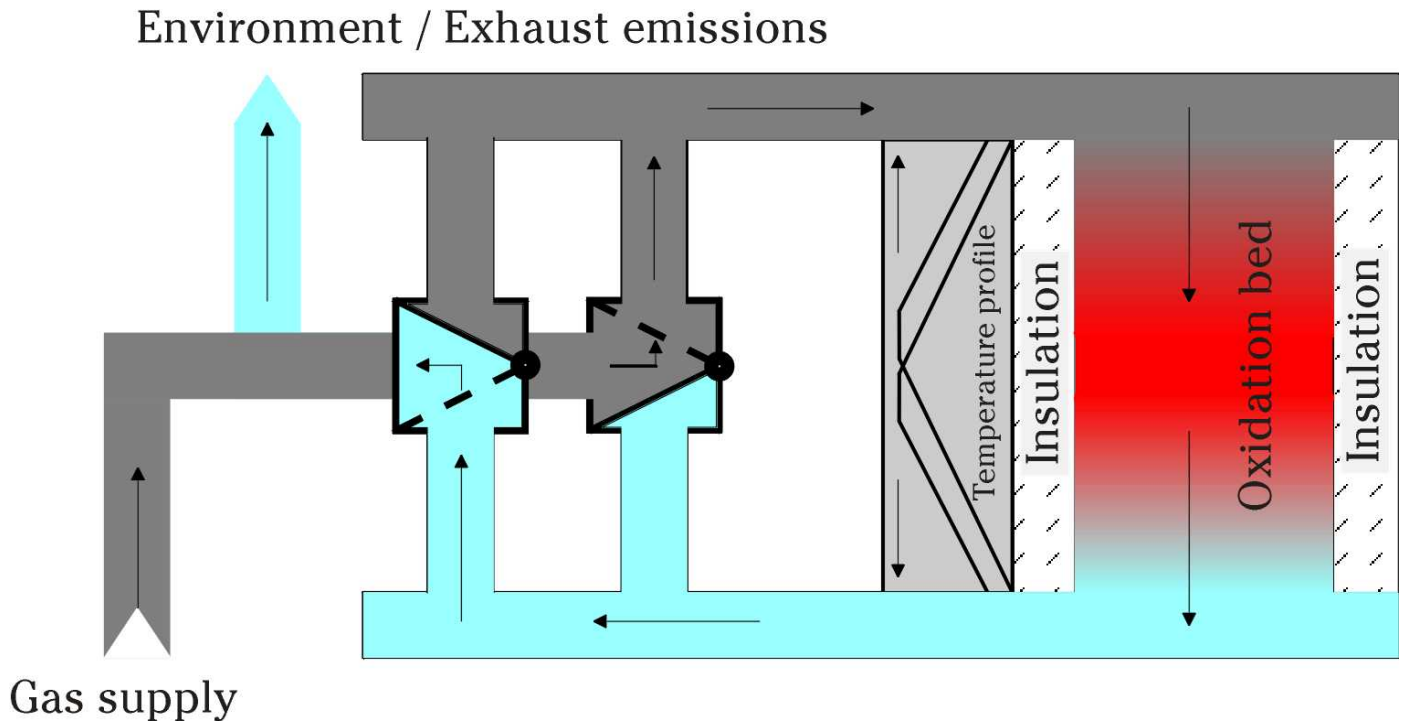
Flameless non-catalytic oxidation



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VocsiBox®

With the relentless pressure on industry, and in particular the waste management industry, to reduce emissions, a technical gap has appeared in the market for dealing with low calorific value gases. However, there is now a new, practical and cost-effective method of dealing with these gases.

New VocsiBox® challenges the fashion for flares

The last twenty years have seen an evolutionary change in the methods used to safely dispose of landfill gas, as both industry and regulators have come to grips with the scientific and engineering aspects of landfill gas combustion. The process, which in the early days simply involved a pipe in the ground and an oily rag being lit to ignite the gas, has progressed to the high technology flares of today which are designed to meet very stringent performance criteria such as reliability, noise and emissions.

The predominant driving force behind these developments has been the need to meet ever tighter emission and landfill gas management standards. Ever since the days of the Waste Regulation Authorities and their eventual successors the Environment Agency (EA) we have seen a continuous evolution in standards, as is clearly reflected in the series of Waste Management Guidance Papers published over the years.

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Naturally the emphasis of guidance documents has broadened over the years from looking at landfill gas purely from the narrow perspective of migration and consequential risk of damage to property, crops and life. Current concerns have expanded to include:

- Landfill gases' role in contributing to global warming; methane is approximately 20 times more effective as a greenhouse gas than carbon dioxide.
- Odours from landfill sites.
- The health effects of both landfill gas and gaseous emissions from flares.
- The overall impact of gaseous emissions resulting from the combustion of landfill gas on local air quality.
- The impact of gas process and flaring systems on adjacent properties amenities (both visual and noise impact).

These concerns have presented a number of apparently conflicting requirements from both landfill operators and flare designers. In particular:

- To achieve good dispersion and so minimise the impact of emissions from flares on local air quality you need a very high flare stack, but this often conflicts with planning requirements to minimise the visual impact of any gas process facility.
- Passive venting of landfill gas is no longer acceptable, so overall the quality of landfill gas (i.e. the methane content) being fed to flares is reducing - to the point that in some cases it is simply not combustible. This conflicts with modern flares' need for a good quality gas supply to maintain a high temperature (i.e. 1000^{o}C to 1200^{o}C) to ensure complete and efficient combustion of the gas to meet tight emission standards.

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Taking the first issue of flare height, negotiations between site operators, flare manufacturers and planners are enabling an acceptable compromise to be achieved on most sites. However, up until now the options open to site operators have either been highly inefficient or very costly:

- Biofilters have been used to treat low calorific value methane, and whilst these devices do reduce odours associated with landfill gas they are highly inefficient at breaking down the methane content of landfill gas.
- Incineration of landfill gas with flares fired with auxiliary gases are highly efficient but very expensive both in terms of the capital costs and the ongoing running costs of supplying auxiliary fuels to the flare.

To these two options can now be added a third alternative, with the launch of VocsiBox®, developed by Haase Energietechnik (Germany). The VocsiBox® has successfully combined the advantages of both the aforementioned systems without over stretching tight budgets.

Supplied in a standard ISO container designed on a Plug and Play philosophy, the system works by oxidising all volatile organic compounds (VOC) present in the gas stream. When compared with a high temperature flare, the VocsiBox® achieves the same degree of efficiency in oxidation of VOC, however the VocsiBox® achieves this standard with input gases which have methane contents as low as 0.3% v/v.

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Technical Description

The process of oxidising VOC is an exothermic process, which overall results in the release of energy. As the VOC content in the input gas stream to the VocsiBox® is oxidised, the energy released is transferred to the ceramic bed, this process both cools the gas and heats the ceramic bed. It is important to note that the ceramic bed does not act as a catalyst nor does it take part in the chemical reaction of oxidising the VOCs. The hot ceramic bed then transfers the heat to the input gas and raises the gas temperature to its reaction temperature, at which point the VOCs in the gas stream react with atmospheric oxygen.

Due to the fact that very little energy is lost from the process (outlet gas temperature is only slightly higher than input gas temperature and minimal heat loss through radiation) very little energy is required to sustain the reaction process. Hence this regenerative combustion process requires only an input gas stream with a methane content of 0.3% v/v without auxiliary gases to operate autothermally.

One of the side effects of the process is that the reaction zone within the ceramic bed will tend to move along the bed in the same direction as the gas flow. Therefore - to ensure that the hot reaction zone and cooler heat transfer zones do not move out of the bed - the hot reaction zone is maintained in the middle of the bed by reversing the gas flow at regular intervals.

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One of the key benefits of the system is that its environmental performance is very good for the following reasons:-

- No auxiliary energy inputs (provided input gas stream has a methane content of more than 0.3% v/v), therefore overall CO_2 emissions are kept to an absolute minimum.
- Strong greenhouse gases (i.e. methane etc.) are converted into carbon dioxide which is a much weaker greenhouse gas, therefore there is an overall reduction in the greenhouse effect resulting from unavoidable gaseous emissions from a site.

Another benefit is that due to the fact that the unit is non-selective about the type of VOC it can oxidise, there is a whole range of other applications where a VocsiBox® can be used to reduce emissions, for example exhaust air from compost treatment plants. In addition, as a result of the high temperatures in the unit, the VocsiBox® can be used in situations where the destruction of pathogens and other germs is necessary.

For further information, please contact:

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Specialised acc. to 19 l WHG
and accredited to ISO 9001

Integral landfill disposal
Landfill gas, sludge gas, biogas technology, leachate treatment, anaerobic technology.

Environmental technology / plant construction
Disposal of toxic gases, waste water treatment, granular drying, CHP units, refrigeration engineering, services.

Plant construction *Operation* *Service*

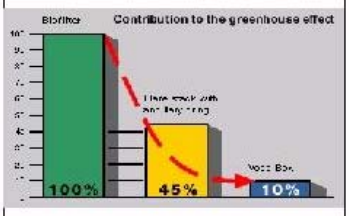
High Temperature Disposal of Poor Quality Landfill Gas

Landfill operators are under increasing pressure to better control landfill gas migration and to reduce methane emissions to atmosphere from vents. This often means that poor quality gas either needs to be collected and burnt in high temperature flares with very expensive supplemental fuels or passed through highly inefficient bio-filter to ensure that the Environment Agency's new stringent emission criteria are met in full

Solution

This is where the VocsiBox®, developed by Haase Energietechnik in Germany and marketed in the UK by Clarke Energy, has successfully designed and built a systems that combines the simplicity of bio-filters with the efficiency of high temperature flares to dispose of very poor quality landfill gas without overstretching tight budgets. The VocsiBox® supplied in a standard ISO container works by oxidizing all volatile organic compounds (VOC) present in the gas stream. When compared with a high temperature flare the VocsiBox® achieves the same degree of efficiency in oxidation of VOC, however the VocsiBox® achieves this standard with input gases with methane contents as low as 0.3% v/v.

Not only is the VocsiBox® the most practical alternative it is also the most environmentally friendly option, with the lowest relative contribution to greenhouse gases of the three technologies.



Plug and play systems

Being fully containerised The Haase VocsiBox® is fully operative when supplied to site. Trial runs are carried out at the factory prior to delivery. All that is required on site is the connection of a gas supply and an electrical power supply.

Mobile units for trial, safety and emergency operation are available at short notice.

Technical Data

- Models with maximum flow rates from 1,500m³/hr to 50,000m³/hr.
- Complies with strictest European Emissions legislation.
- Negligible NOx production.
- 95% - 98% nominal heat exchange efficiency.
- Minimum gas quality 0.3% v/v CH4 for auto-thermal oxidation.
- 900°C - 1000°C combustion temperature.
- Turndown ration 5 to 1 (9 to 1 optional)
- High safety standards

VocsiBox®

The alternative to auxiliary feed gas flares or venting the gas of low calorific value

Introduction

The technical gap within the treatment of landfill gas and other waste gases of low calorific value is closed by the flameless, non-catalytic oxidation process.

You think a high temperature flare is too expensive and biofilters or venting are not efficient enough? Now, there is an alternative solution for you: Haase Energietechnik has developed a new process for the treatment of gas with low calorific value escaping from municipal solid waste landfills or from old landfills with non-inflammable methane contents and any other low calorific value gas. This new technology combines the advantages of the two conventional methods without overstretching smaller budgets.

Gases of low calorific value are a significant problem to the environment. Some examples are landfills still in operation, landfill gas from deposited pollutants, as well as exhaust air from waste treatment or compost plants. The disposal of this exhaust air in accordance with the laws and regulations in force (reduction of the green house effect!) can be very cost-intensive due to special taxes, especially when the degree of contamination is rather high as it is quite often in the case of landfill gas (feeding with natural gas for flaring).

Inflammable gas is divided in different categories reaching from gas with low calorific value to gas with high calorific value. A gas is classified to be of low calorific value if it is lower than 9 MJ/kg. In the case of landfill gas this corresponds to a methane content of approx. ≤ 25 Vol. %. This gas does not burn self-sufficiently.

Inflammable gas like landfill gas is being destroyed via high temperature flare or by being used as fuel for gas motors. The main aspect here is either the destruction of pollutants or the maximum energy recovery.

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The range of treatment for non-inflammable gas reaches from ventilation to the environment over deodoration with biofilters and direct venting to high temperature flare with auxiliary gas. The choice of the treatment procedure depends on the toxicity and odours of the pollutants in the gas and on economical reflections.

Biofilters are an economical solution. However, the decomposition of various pollutants in the biofilter is rather low and depends on the high amount of technical support given. Methane, having a large influence on the climate, is almost not destroyed at all. (e. g.: „UK Landfill Gas Conference: From Research To Policy on 24th March 1999, Kenilworth; "Deponietechnik 2000", conference on 26/27.01.2000 in Hamburg, Prof. R. Stegmann; Prof. G. Reltenberger).

High temperature flares work in accordance with all relevant emission regulations (e. g. UK Guidance for Best Practice Flaring of Landfill Gas), but since they need auxiliary gas, this process could be rather expensive (see table below).

A new alternative to high temperature flares, venting and biofilters is the flameless, non-catalytic oxidation. For this purpose, Haase Energietechnik has developed the so-called VocsiBox®. It is delivered in standard ISO containers turnkey.

The aim of this thermal regenerative combustion plant is the oxidation of all impurities and odours contained in the incoming gas. Compared to a high combustion flare, the VocsiBox® reaches an equal degree of efficiency concerning the oxidation of all contaminants. However, a VocsiBox® works in most cases without auxiliary gas (methane content ≥ 0.3 Vol. % in the ordinary landfill gas).

Technical description

This oxidation of the gas phase releases the energy contained in the lean gas. During the flow through the plant, the gas releases this energy to the reactor bed. There is no chemical reaction between the gas and the ceramic material inside of the reactor.

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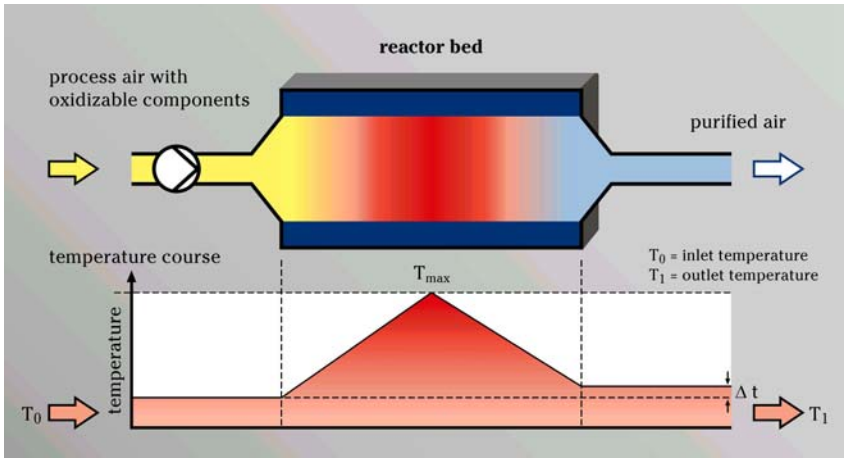
The VocsiBox® is a single-bed plant. The reactor bed heats the process air to the respective reaction temperature, and after the oxidation process has taken place, it cools the hot air and consequently assures heat recovery. This double function is possible because the reaction temperature is held in only a part of the bed. The gas is heated to the reaction temperature while flowing through the bed. Here, the gas contents react with the atmospheric oxygen.



Function of the VocsiBox®

Due to the fact that the gas inlet temperature is only slightly higher than the outlet temperature, only very little energy is necessary to assure the process. This is why this process is also called regenerative combustion or oxidation. By continuously changing the direction of the flow, the hot oxidation zone is kept in the middle of the reactor bed.

The losses of radiation and those of energy caused by the slightly higher outlet temperature of the gas must be compensated by the energy contained in the inlet gas flow if the plant is to operate autothermal (≥ 0.3 vol. % CH_4 in the inlet gas, calorific value of only 0.11 MJ/kg), i. e. without auxiliary gas. In case the ratio that surface bears to volume of the reactor is favourable, a good utilisation of heat is assured and so an autothermal operation with very low energy contents in the treated lean gas is possible.

Since the VocsiBox® works on the principle of non-catalytic oxidation, also non-inflammable gas mixtures can be oxidised directly. The VocsiBox® procedure combines the simplicity of biofilters with

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the efficiency of a high temperature flare – in general without causing additional CO_2 emission. Therefore, it contributes largely to reducing the greenhouse effect compared to the use of biofilters or to a direct venting to the atmosphere.

Highly charged mixtures can stay below the LEL-limit when being mixed with ambient air. Mixtures with a lower charge can be prepared for oxidation by adding auxiliary gas. The required gas amount is much below the one needed for feeding high temperature flares. Operators and the authorities responsible for environmental politics are confronted with the fact that the methane content in the landfill gas escaping from municipal solid waste landfills is reduced with the increasing age of the landfill site. On old landfill sites, the methane production is generally low. Also in this case, measures have to be taken to reduce emissions and the conventional technique of high temperature flares cannot just be simply applied.

One of the biggest problems in the after-care of abandoned polluted areas are old landfill sites converted into residential or industrial areas. A passive disposal of gas via biofilter or a simple ventilation is not sufficient. Only an active gas disposal plant like the VocsiBox® can assure that no explosive gas mixtures can build up in the basement or in the living space. The contamination and odours in these areas and in the ambient atmosphere are kept as low as possible.

Further applications:

Lean gases charged with methane and unhealthy gaseous components are also produced in waste treatment plants or compost plants. The ecological release of these components into the atmosphere is part of the whole waste treatment concept.

Another aspect is the presence of germs in the waste gas of such plants. This lean gas can only be made hygienic with a respective heat treatment, but a biofilter is not able to attain the necessary temperatures. Also in this context, the use of a VocsiBox® meets all respective requirements.

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In summary, it can be said that the VocsiBox® offers a technology for the disposal of landfill gas from abandoned polluted areas or former landfill sites whose investment and operating costs are comparable to those of a biofilter or a high temperature flare plant, and at the same time, the VocsiBox® contributes largely to the reduction of the greenhouse effect.

Comparing Investment and additional costs (in £) on .....

		Biofilter	**High temperature flare with auxiliary gas**	**VocsiBox®**
Investment	a)	60,000 – 90,000	80,000	215,000
	b)	50,000 – 60,000	65,000	130,000
Operating cost (8,000 h/a) (electrical energy, auxiliary gas, backfill, water etc.)	a)	35,000 – 39,000	73,000 – 75,000	30,000 – 32,000
	b)	22,000 – 25,000	48,000 – 50,000	17,000 – 19,000
Maintenance cost per year	a) + b)	3,000	3,000	3,000
Emission standards	a) + b)	only odour	≤ UK Guidance	≤ UK Guidance
Reduction of greenhouse effect with regards to CO_2	a)	negligible	19,600 tpa	21,300 tpa
	b)	negligible	6,100 tpa	7,200 tpa

a) 900 m³/h landfill gas, charged with 17 Vol. % CH_4
b) 400 m³/h landfill gas, charged with 13 Vol. % CH_4

Energy cost: 4 pc/kWh electrical energy
26pc / Therm (0.887pc/kWh) natural gas

All systems incl. centrifugal boosters
Emissions standard: Interim Internal Technical Guidance for Best Practice Flaring of Landfill Gas

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Haase-VocsiBox®

Autothermal oxidation

for landfill and other waste gases of low calorific value

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Non-catalytic oxidation

The process

Generally, gases of low calorific value (e.g. non-inflammable landfill gas) have previously been treated by means of a biofilter or a TA-Luft flare using natural gas as a support fuel.

Flameless process

The VocsiBox® is a self-regulating reactor with a new oxidation system which oxidizes virtually all the volatile organic compounds; flameless (therefore giving very low NO_x-emissions) and without using catalyzers.

The low calorific value gases are fed over the reactor bed at a working temperature of about 1,000 °C, the flow direction being either unidirectional or periodically reversed, depending upon the calorific value and oxidation speed of the waste gas to be treated.

High cleaning efficiency

Within the normal temperature range (see picture 1), virtually all the hydrocarbon compounds are oxidized within the reactor bed.

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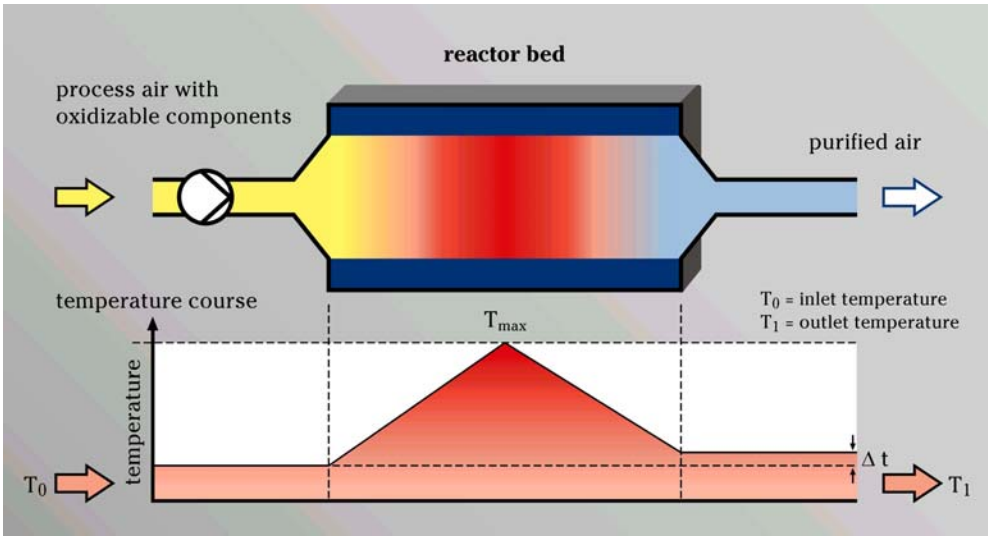

picture 1: Temperature curve inside the VocsiBox®

Autothermal process control

After the starting-phase, the oxidation process takes place in an autothermal way, i.e. without supply of additional energy. During the continuous operation, the energy from the low calorific value gases are released by oxidation. The energy of the cleaned process air is saved in the reactor bed, so the reactor is kept at operating temperature.

A PLC regulates the temperature of the reactor bed in order to ensure that the required temperature is maintained. The addition of ancilliary gas is only necessary when there is an extremely high pollutant concentration (calorific value below 0.025 kWh/m³).

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Favourable in price and environmental-friendly

Advantages

The VocsiBox® offers both economical and ecological advantages.

Low overheads

Owing to the autothermal process control, the VocsiBox® offers an efficient energy balance. Electrical energy is only required during the starting-phase for heating the reactor to the required working temperature with the result that the operating costs are very low.

High availability, low maintenance required

Owing to the tough construction of the VocsiBox® and its very few moving parts, it is wear resistant, easy to operate, and requires very little maintenance.

90% less greenhouse gases

The high efficiency of the VocsiBox® can be best seen when comparing emissions (CH_4, CO_2) of the VocsiBox® with those of other gas treatment plants (e.g. see picture 2).

If it is assumed that the value of the greenhouse effect is 100% when using a biofilter, then the use of a flare would release 45% and the VocsiBox® only 10% if fed with the same crude gas quantity and quality.

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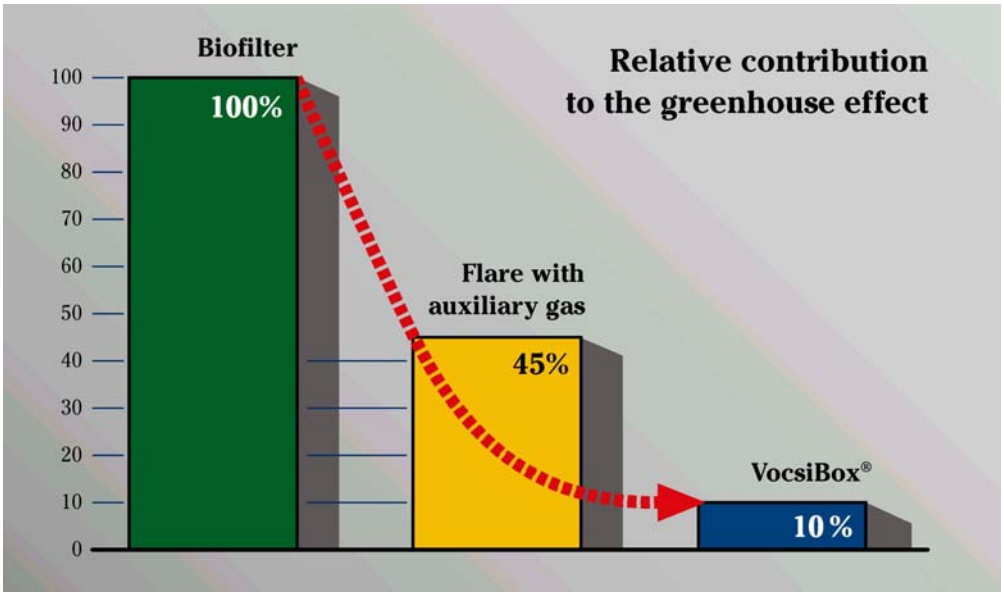

picture 2: Relative contribution to the greenhouse effect

Minimum emissions

The emissions of the VocsiBox® are far below those of a corresponding TA-Luft flare.

Gas treatment plants

DAS – IB designs and constructs gas treatment plants for all kinds of contaminated gases both with or without energy utilization.

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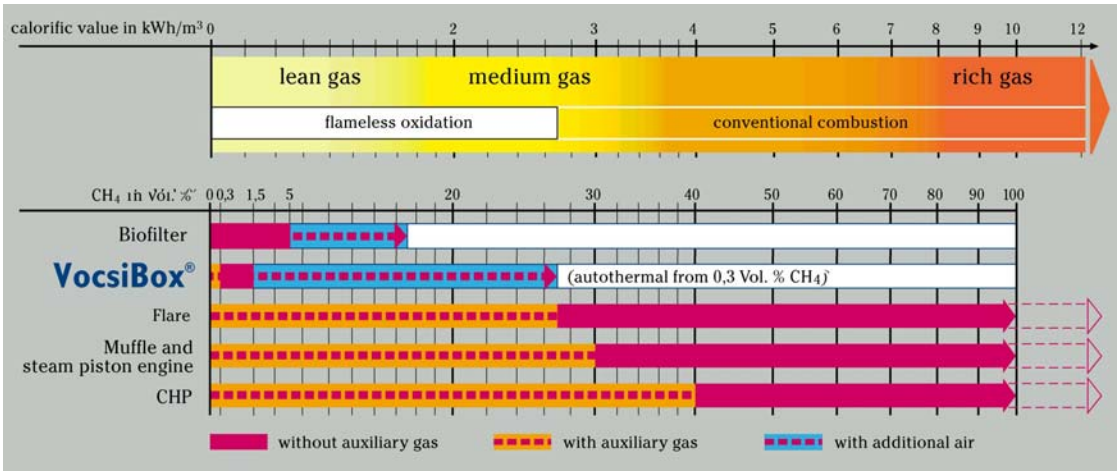
Depending upon the individual requirements the following devices may be used:

- Biofilter
- VocsiBox®
- High-temperature combustion plant
- Muffle + steam piston engine
- Cogeneration plant, CHP unit

The calorific value (Vol.% CH_4) and the pollutant concentration in the crude gas are the main deciding factors for choosing the appropriate process (see picture 3).



picture 3: Gas levels for operation of the different gas units

1. Biofilter

The biofilter is a favourable process for reducing odours, however, the CH_4-content of the waste gas is actually not much reduced.

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2. VocsiBox®

The operating range of the VocsiBox® is approx. 0 - 27 Vol.% CH_4. Odour components and methane are virtually fully oxidized. Even from 0.30 Vol.% CH_4 on, the oxidation process in the VocsiBox® takes place autothermally.

3. High-temperature combustion plants / Flares (HTV)

High-temperature combustion plants (Flares) are able to crack pollutants at temperatures of up to 1,200 °C. The gas can be burned without additions from 27 Vol.% CH_4 upwards or with the additon of ancilliary gases below this value.

4. Muffel + steam piston engine

The utilization of energy is even possible from a CH_4-content of 30 Vol.% on. The gases are burned in a muffle and the exhaust heat is used for operating the steam piston engine via a downstream connected waste heat boiler. The main advantages of this solution are the very low overheads and the very low pollutant concentration in the exhaust gas.

5. CHP – units, gas engines

From 40 Vol.% CH_4 on, the gas can directly be used for operating gas engines of a cogeneration plant (CHP) as long as the pollutant concentration permits. Compared to the combination muffle + steam piston engine, the electrical efficiency of a CHP is much higher.

CHPs can be delivered as stationary construction or as turnkey - containerised plants ready for connection.

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Standard sizes of the VocsiBox®

Type	VB I	VB II	VB III	VB IV	VB V
Flow rate (m³/h)	300 - 1,000	1,000 - 5,000	5,000 - 10,000	10,000 - 15,000	15,000 - 20,000
Measurements L x W x H (m)	3.1 x 2.4 x 2.3	3.1 x 2.4 x 2.5	4.5 x 2.4 x 2.5	5.7 x 2.8 x 2.7	7.0 x 2.8 x 2.7
Mass	8 t	8 t	15 t	20 t	25 t
Compressed air requirements (medium/high)	15/60 l/min	15/60 l/min	40/60 l/min	50/200 l/min	50/200 l/min
Pressure loss reactor	50 mbar	63 mbar	46 mbar	50 mbar	42 mbar

Flare and VocsiBox®

View inside the VocsiBox®-container
IN BARSBÜTTEL

VocsiBox® in Hanover-Bernerode
(PARKING LOT EXPO 2000)

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