rexresearch.com

Gary LEWIS
Diesel Exhaust Fertilizer System

Diesel tractor exhaust injection into soil sequesters CO2 (400 HP = 1100 Kg / hectare), eliminates fertilizers, improves growth.

http://www.theage.com.au/national/a-farmers-field-of-dreams-buries-climate-change-war-20091031-hqty.html
November 1, 2009

A farmer's field of dreams buries climate change war
by Carmel Egan

A BATTLE is raging beneath the bobbing heads of Ian Linklater's wheat crop in the red, loamy soils of Gol Gol.

In this break-your-heart farming land near the Murray River, north of Mildura, the enemies are drought, nutrient depletion, salt and rising farming costs.

The battle's unlikely heroes are Mr Linklater and his 400-horsepower, oxygen-sucking, diesel-guzzling, carbon-spewing tractor.

International debate rages over the cost and plausibility of reducing greenhouse gas emissions from coal-fired power stations by pumping carbon underground.

But Mr Linklater is literally ploughing ahead, injecting his tractor's fossil fuel exhaust fumes directly into the ground, where they enhance the biochemical interaction between plants and soil microbes. And it seems his home-grown version of carbon sequestration, introduced in 2007, is getting results, with this year's crop, aided by better rainfall, his best since 2001.

"It might not seem that emissions from one tractor could do a lot, but per hectare it emits 1100 kilos of carbon," Mr Linklater says.

Adapting methods developed by Canadian farmer Gary Lewis, of BioAgtive Technologies, Mr Linklater spent $20,000 customising equipment that cools the tractor's fumes to 30 degrees then expels them into the soil as gas fertiliser when he sows his crop.

His trials, which are being replicated in Canada, Britain and South Africa, are gaining global attention and are now the focus of scientific research. "When I heard about it, I listened and the science of it seemed to make sense, but with fertiliser costs at about $1200 to $1500 a tonne, the economics of it got me into gear," Mr Linklater says.

At today's prices it would have cost him $500,000 in phosphorous and nitrogen fertilisers to prepare 3900 hectares for planting. But in the two years since he and his sons began trialling the new technique, no fertiliser has been applied. The saving is enough to wipe a healthy chunk off the debt that he, like many drought-stricken farmers, has racked up through years of meagre rain and below-break-even wheat prices.

Political debate continues over inclusion of agriculture in Australia's emissions trading scheme, but Mr Linklater says farmers have nothing to fear from such a scheme. "It's coming anyway, regardless of what happens in Australia. Governments around the world are moving ahead with carbon taxes and we will all have to pay."

The Federal Opposition has proposed amendments permanently removing agriculture's methane emissions from an emissions trading scheme while allowing farmers to make money through carbon credits earned from replanting trees and storing carbon in the soil.

The Government has delayed a decision on agriculture, which accounts for 18 per cent of the nation's greenhouse gases, until 2013.

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http://www.hcn.org/issues/44.8/recycling-diesel-emissions-for-farm-fertilizer
May 14, 2012

Recycling Diesel Emissions for Farm Fertilizer

by

Marian Lyman Kirst

The summer of 2007 was one of the driest and hottest on record in Montana. Fields withered along the state's arid Hi-Line. But in the small, north-central town of Rudyard, one emerald-green cornfield stood out amid the brown. The field was a test plot grown with a technology that only a fed-up farmer could have invented: a system that turns diesel tractor exhaust into plant food.

That farmer is Canadian Gary Lewis, a trained mechanic and the inventor of Bio-Agtive Emissions Technology, a tractor add-on that recycles diesel emissions into fertilizer.

He came up with the idea back in 2001, when despite his careful applications of pricey fertilizer, his timothy hay fields failed to grow. Lewis, who has a wife and five kids, was devastated.

He believed that years of dousing his fields with chemical-heavy fertilizer had made the soil too salty, less biologically active and unable to retain moisture. So he decided to jump off the chemical treadmill and find another way to tend his plants, which on their luxury diets had grown lazy.

Lewis, who looks like an "American Gothic" version of John Elway, has the tenacity of a champion quarterback. He spent the next year poring over plant-science textbooks like Horst Marschner's Mineral Nutrition of Higher Plants. Armed with a new understanding of soil and plant health, Lewis used his automotive skills to implement what he fondly calls his "crazy idea": harnessing the carbon dioxide, nitrogen gas and heavy metals -- zinc, copper, magnesium and iron -- in tractor exhaust and using them as fertilizer.

His invention cools the exhaust, runs it through a metal tubing system, and feeds it into the tractor's air seeder. Those emissions are then injected into the ground along with the seeds. Lewis believes this stimulates soil microbes and beneficial root fungi, whose activity liberates nutrients already in the ground and increases the plants' ability to absorb both nutrients and water.

"My tractor became a living thing, burying all of its energy to feed things in the soil — bacteria and fungi and micro-invertebrates," he enthuses.

The Bio-Agtive process also coats the seeds with emissions, which Lewis believes protects them against soil pathogens. Some of the minor emissions from diesel engines, such as formaldehyde, are the same chemicals used in protective seed treatments, he says.

More than 100 farmers in the U.S. and Canada have purchased Bio-Agtive through Lewis' company, N/C Quest Inc. But like any innovation that promises revolution, the system has its skeptics. "People thought I was burying poisonous gas in the soil!" says Lewis. Admittedly, diesel emissions are far from healthy for people. Yet Lewis contends they are fine for plants.

To help prove it, he enlisted the support of Montana State University Northern's Bio-Energy Center, which began testing Bio-Agtive on spring wheat crops last year with the help of a Montana Research and Commercialization Board grant. Though preliminary, the results are promising: The center didn't detect any dangerous heavy metals in the grains or tissues of emissions-treated plants, and, after one season of testing, found higher yields and increased soil phosphorous levels in those, compared to fertilized fields. What's more, the acidic condensate associated with the cooled emissions helped reduce the test plots' alkaline soil (common in the arid West) to more neutral levels.

The center is also testing Bio-Agtive with biofuels like camelina biodiesel, the use of which could reduce farmers' dependence on both fossil fuels and fertilizer.

Canadian soil ecologist Jill Clapperton has spent the last five years investigating Bio-Agtive's effects on soil, seeds and plants, working both with the Bio-Energy Center and the National Research Council of Canada.

"When a farmer uses Bio-Agtive," says Clapperton, the seeds "become extremely coated with soot and exhaust emissions … they get very, very black." But the coating does not seem to reduce germination rates, as she had suspected it might. She also looked for negative effects on soil health -- respiration, the microbial community -- but found none.

Lewis, she says, may be correct that emissions-coated seeds are better able to fend off potentially pathogenic fungi, but she stresses that more research is required. Clapperton's less sure, however, about Bio-Agtive's potential as a fertilizer. There are clear differences between the control and emissions-treated plots, she says. "But whether (those changes) relate to Gary's theory as he sees it is another question." Montana State University agronomist David Wichman worries Lewis' too-good-to-be-true tech is just that. He did not see yield increases in his research trial of Bio-Agtive on winter wheat, though he acknowledges the testing was limited in scope. He cautions farmers to wait for scientific proof before spending $30,000-$55,000 on a Bio-Agtive system.

Lewis responds that the price is "about the same as one truckload of fertilizer." Indeed, small-grain farmer and Bio-Agtive distributor Craig Henke of Chester, Mont., says the system saves him $50,000 a year in phosphate fertilizer costs. He still applies some nitrogen to his plants but says he has seen a four-fold increase in soil phosphorous levels since he started using Bio-Agtive six years ago.

For Lewis, it's all about helping farm families gain some independence and security.

"When you are addicted to something, it's hard to take the risk to quit. But the best thing with this technology is that, in the gambling game of farming, you are keeping money in your pocket.

Videos

http://www.youtube.com/watch?v=slFQoRFoMfk

Bio-Agtive Gathering 2013 Alberta Canada

http://www.youtube.com/watch?v=9R2vzyz7ESg

http://www.youtube.com/watch?v=ZZguPdtRvXk

http://www.youtube.com/watch?v=hN2xnNhuiHo

http://www.youtube.com/watch?v=S25CrbULPaI

http://www.youtube.com/watch?v=XgszQKUyBXA

http://www.youtube.com/watch?v=bK1sLcGiYdk

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http://www.bioagtive.com/?s=1&p=413&op=153

Dr. Jill Clapperton Speaks

Dr. Jill Clapperton, formerly with Agriculture Canada's Lethbridge Research Station for 16 years and now the principal of EarthSpirit Land Resource Consulting, leads the way in trying to find out exactly how exhaust does what it does in the soil. Here's what she had to say about our Bio-AgtiveTM Emissions Technology at our 2008 convention:

"It works, and its my job to find out how it works. We will be able to tell you exactly what's happening in the soil in 3-5 years."

"Gary's great goal is to make sure that people are growing food that is really good for them, and that they're doing good things for the soil - that they're taking care of their soil so they can grow great food."

"...what is really nice about using the exhaust is that we're not using too much phosphorous."

Dr. Jill has an extensive ongoing research program.

What has been researched?

What's going on in the soil as a result of our injection of exhaust emissions? The summer of 2007 saw the first real scientific research into our Bio-Agtive™ Emissions Technology. In two separate arms-length experiments co-funded by the National Research Council of Canada and N/C Quest Inc. (one in Alberta and one in Manitoba), two eminent Canadian agricultural scientists headed teams that seeded and monitored test plots with various crops, fertilizer and exhaust emissions treatments in two totally different areas of the country.

Unfortunately the Alberta experiment supervised by Dr. Jill Clapperton was completely hailed out and yielded only limited data. Dr. Clapperton was, however, able to review and assess the research data, crop yields, soil tests, tissue tests, and anecdotal evidence collected elsewhere in 2007. With regard to the 2006 and 2007 yields of our licensees, she states that, while we may not know exactly what is going on below ground, "plants are indicators of what's going on in the soil, so plant success is always the first step [in proving the value of new technology]".

The Manitoba experiment was a resounding success despite the extreme drought conditions in that area. What our scientific team found was "agronomy test data to show that exhaust stimulated soil nutrient release and uptake by both canola and wheat", according to Dr. Loraine Bailey.

Continued research has been carried out in 2009/2010 with Dr. Clapperton and research summary for 2009 was released showing Yield Data in Stome, AB

Montana State University Northern, Havre MT have a grant for the State of Montana USA to examine the quality of exhaust emissions, and how much exhaust is placed with the seed. A further grant offered trials in 2011 that have also received good results in determining how much life is in the soil before seeding, after seeding, after harvest with treatments as; check, diesel, bio-diesel, fertilizer. The scientific results have been published and the report is viewable under "Montana State University Northern" tab.

Among the latest in research is or “Africa Project” lead by Mick Dennis of Field Master Ltd. in Arusha Tanzania. After entering the African Enterprise Challenge of 250 contestants, Bio-Agtive™ placed first and was granted $400,000 to do further research in Tanzania on the technology. Updates will be continually posted as we get them!

No funding or grants have been received yet in Australia but we look forward to running separate independent trials at future field days in 2012 year, we will keep it updated.

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http://www.bioagtive.com/

About Bio-Agtive

Bio-Agtive Farming

Our Bio-Agtive™ Emissions Technology (BAET) is the culmination of more than nine years of experimentation by Mr. Gary Lewis on his own farm. His worldwide Patent Pending technology has two major components; the Bio-Agtive Emissions System (BAES) which is the mechanical system that captures, processes, and injects the exhaust emissions into the soil, and the Bio-Agtive Emissions Method (BAEM) - Gary's unique theory of how the soil and the plants growing in it interact biochemically, and are enhanced by, exhaust emissions. One part of the BAE Technology is useless without the other:

The BAE System: because every producer's equipment isn't the same our distributor in your area will supply and install it in your farm shop to fit your equipment and your crop needs. That way you understand the inner workings of your BAE System.

The BAE Method: your distributor will spend the time necessary to teach you how to use our technology properly to maximize your crop yields while minimizing your fossil fuel and fertilizer inputs, and ongoing advice will always be just a phone call away.

BioAgtive Technologies

Our quest is to help agriculture to understand and practice a new way of Nitrogen and Carbon cycle management.

N/C Quest Inc is the parent company that license's the Bio-Agtive™ Technology Method to farms at the farm gate around the world! We have over 150 farms in Canada, Jamaica, USA, Australia, England, South Africa, Tanzania, Kazakhstan and Japan are now licensed to use our Bio-Agtive™ Emissions Technology (BAET) with our distributor network continuing to grow worldwide each year.

A distributor in your area would be more than happy to talk to you at your own farm, tell you their experiences, and help you become a better producer while improving your bottom line! For a distributor contact in your area, you can find under the Distributors and Products tab or contact sales@bioagtive.com

Bio-Agtive™ System Kits

All prices are pre-tax, and payable in currency of the country you reside in, however prices may vary depending on your country, size and make of your tractor/equipment. The total costs of a Bio-Agtive™ System fitted to a 250HP-600HP tractor is estimated to between $40,000 and $57,000 depending on unit and installation costs.

We want our users to be satisfied and have safer operation with all their equipment, especially with new technology. If you are wanting full benefits of using the technology to be achieved then we recommend dealing with only NCQ Sales Represensatives found here on the NCQ Distributor list - For Your Safety and Ours!

Bio-Agtive™ Patent Pending

N/C Quest Inc. has worldwide "Patent Pending" status on all aspects of the Bio-Agtive™ Emissions Technology to protect our Licensees, our Distributors, our Manufacturers and you - our potential customer. Our low initial Technology Use Fee (license) to use the BAE Technology is purposely kept that way because we want our company to grow farmer to farmer, with Licensees becoming Distributors and Manufacturers - neighbours helping neighbours!

And as a Licensee of the Bio-Agtive™ Emissions Technology from N/C Quest Inc. you get two priceless advantages. First, you have access to the ongoing collaborative research into our revolutionary Bio-Agtive™ Emissions Method. We will always guide you with the latest advice about the BAEM via our website, online web seminars, emails, and alerts - as well as traditional offline means!

Second, you have access to The CO2Xchange™, our Patent Pending carbon sponsorship program that lets enlightened consumers around the world sponsor you to practice more sustainable farming practices while you clean their air for them. Forget carbon offsets (they're next to worthless) and join N/C Quest Inc. as we help agriculture help the planet breathe easier via the "CO2X"!

Fertilizing system and method by extracting nitrogen compounds from combustion exhaust gases
US7487927
CA2504133

A fertilizer system is provided using extraction of nitrogen compounds and other plant nutrients from combustion exhaust gases, and which is particularly suited for use with an agricultural irrigation system or engine driven plant care equipment including self-propelled tractors, mowers and the like. The system includes an exhaust chamber in communication with the motor driving a pump of the system for receiving the exhaust gases therethrough. Water is injected into the exhaust chamber for mixing with the exhaust so that the steam being formed absorbs various nitrogen compounds and other plant nutrients from the surrounding hot exhaust gases. The steam is subsequently condensed in a condensing chamber from which condensate is collected and dispensed into the inlet of the pump with water circulated therethrough.; The water is thus enriched with various nitrogen compounds and other plant nutrients absorbed from the exhaust gases before being dispensed to a planted area by an irrigation system or a sprayer attachment on a self-propelled tractor, mower and the like.

FIELD OF THE INVENTION

[0001] The present invention relates to a method and system for fertilizing using extraction of nitrogen compounds and plant nutrients from combustion exhaust gases, and more particularly to such a system or method when used for extracting nitrogen compounds and plant nutrients from exhaust gases, for example, in either an irrigation pump motor of an agricultural irrigation system for subsequent use of the nitrogen compounds in irrigation water of the irrigation system or in a driving motor for driving or propelling plant care equipment including self-propelled tractors, mowers, sprayers and the like.

BACKGROUND

[0002] Various nitrogen compounds and plant nutrients are known to be desirable for fertilizing various plants, in particular crops. Repeated adding of fertilizer to crops however can be time consuming and costly to both purchase and distribute to the plants.

[0003] While forms of nitrogen are known to exist in large quantities in exhaust gases of combustion engines, these forms of nitrogen however are typically harmful to the environment and of little use as a fertilizer.

[0004] U.S. Pat. No. 6,446,385 to Crutcher describes a greenhouse system in which a gas turbine provides heat and power to maintain the greenhouse. An exhaust gas treatment system receives the hot gas from the turbine to remove and convert harmful nitrogen compounds while a fertilization system makes use of the converted nitrogen compounds as fertilizer for feeding the plants of the greenhouse. The method of extraction described refers to European patent application No. 97117779.5. The gas treatment system however requires consumption of an alkaline earth compound to react with nitric acid which is formed to then form an alkaline earth nitrate in an aqueous form. The resulting calcium nitrate or magnesium nitrate which may be produced are harmful to the plants and soil when distributed in excess quantities and accordingly this system would require careful monitoring so that only limited amounts of the fertilizer compound generated by the gas treatment system are in fact distributed to the plants through irrigation thereof in the greenhouse. This method converts NOx to nitric acid to be scrubbed out with earth alkaline in an aqueous effluent, leaving carbon dioxide in the exhaust stream to raise the carbon dioxide levels in the greenhouse.

SUMMARY

[0005] According to one aspect of the present invention there is provided a fertilizer system for extracting nitrogen compounds and other plant nutrients from exhaust gases of a combustion device, the system comprising:

an exhaust chamber having an inlet and an outlet for receiving the exhaust gases from the combustion device there through;
a water injector for injecting water into the exhaust chamber for mixing with the exhaust gases to form a water vapor;
a condensing chamber for condensing said water vapor exiting the exhaust chamber with the exhaust gases to form a condensate solution; and
a collector for collecting said condensate solution from the condensing chamber;
characterised in that said condensate solution being formed comprises water and one or more compounds selected

from the group including nitrate, nitrite and ammonium. Other useful nutrients to the plants which are extracted include sulphur phosphorus, magnesium, zinc, iron, copper and carbon dioxide as a carbonic acid.

[0011] According to a second aspect of the present invention there is provided a method of fertilizing by extracting nitrogen compounds and other plant nutrients from exhaust gases of a combustion device, the method comprising:

operating a combustion device to produce exhaust gases;
directing the exhaust gases through an exhaust chamber in communication with the combustion device;
injecting water into the exhaust chamber for mixing with the exhaust gases to form a water vapor;
condensing said water vapor exiting the exhaust chamber with the exhaust gases to form a condensate solution comprising water and one or more compounds selected from the group including nitrate, nitrite and ammonium; and
collecting said condensate solution from the condensing chamber. Other useful plant nutrients which may be included in the condensate solution as a result of the above steps include: sulphur, phosphorus, magnesium, zinc, iron, copper and carbon dioxide as a carbonic acid.

[0017] According to further aspects of the present invention there are provided fertilizer solutions comprising the condensate solution formed by the system and method noted above.

[0018] The use of water and exhaust mixed together and subsequently condensed produces a solution of water with nitrate, nitrite, ammonium, sulphur, phosphorus, magnesium, zinc, iron, copper and carbon dioxide as a carbonic acid. These are useful to plants when watered therewith without concern of being toxic to the plants when left to operate continuously from an irrigation pump motor in an irrigation system for example.

[0019] As described in our method of extraction, complete conversion to nitric acid is not required as water will scrub out NH_4, NO_2, NO_3, and other plant nutrients such as sulphur, phosphorus, magnesium, zinc, iron, copper and carbon dioxide as a carbonic acid. This would carry the CO_2 to the crop canopy to feed the crop and/or be stored in the soil as a carbon sink. NO_2 (nitrite) will feed soil bacteria and nitrite reductase (NiR) which transforms nitrite to ammonia and the nitrate bacteria will change nitrites into nitrates. Sulphur dioxide can be used by the crop canopy. Sulphur converts to sulphate in the soil for root up take when combined with water in which sulphuric acid is formed

[0020] The use of an exhaust chamber in combination with a water injector permits nitrogen and nutrients to be readily collected from exhaust gases of commonly available combustion devices, including internal combustion engines and the like, at minimal cost and effort as the nitrogen compounds available in the exhaust gases are normally considered useless and therefore typically wasted. Collection of nitrogen compounds and plant nutrients in a condensate is particularly useful in an agricultural irrigation system as compounds are ready for immediate use with little or no effort on the part of the operator of the irrigation system. Further benefits to injecting water into the exhaust chamber for mixing with the irrigation water include preheating the irrigation water with heat from the exhaust gases and reducing undesirable emissions in the exhaust gases due to the mixing of the gases with water vapor in the exhaust chamber.

[0021] There may be provided a distribution system for distributing the condensate solution to a planted area, for example in irrigation system or a sprayer attachment on a self-propelled tractor or mower and the like.

[0022] The condensate solution may be fully and continuously diverted to the distribution system comprising an irrigation system or a sprayer system on self-propelled equipment as it moves over the crop or area of application.

[0023] In a preferred embodiment, only water is added to the exhaust gases to form the condensate solution.

[0024] The combustion device may comprise an internal combustion engine, however other devices known to consume fossil fuels to produce products of combustion may be useful in certain instances.

[0025] The distribution system in a first embodiment comprises plant care equipment, for example a self-propelled tractor or mower, such that the combustion device comprises an engine driving the plant care equipment.

[0026] Alternatively, the distribution system comprises a crop irrigation system, wherein the collector is coupled to communicate with an inlet of an irrigation pump for dispensing the condensate solution into irrigation water passing through the irrigation pump. The combustion device in this instance would comprise a motor driving the irrigation pump.

[0027] The water injector may be coupled to an outlet of the irrigation pump whereby the water injected into the exhaust chamber comprises a portion of the water pumped by the irrigation pump.

[0028] The condensing chamber may include a condenser core which is cooled by irrigation water passing therethrough or other heat exchanger equipment.

[0029] There may be provided a shut-off valve coupled in series between the collector and the distribution system which is arranged to be open only when the distribution system is operating.

[0030] The water injector may include a float valve coupled in series therewith, the float valve being supported in the condensing chamber such that the water injector is arranged to inject water into the exhaust chamber in response to a level of condensate in the condensing chamber falling below a prescribed level of condensate.

[0031] There may be provided a catalytic converter coupled to an inlet of the exhaust chamber for receiving the exhaust gases therethrough prior to the exhaust chamber. The type of catalyst depends on type of fuel used or desired oxidation.

[0032] There may be provided an air pump for injecting air into the exhaust gases near the water injector to assist in converting harmful emissions to more desirable compounds.

[0033] There may be provided high voltage arc means for generating an electric arc in a passage through which the exhaust gases pass also to assist in converting harmful emissions to more desirable compounds.

[0034] There may be provided an electrical field generator surrounding a passage through which the exhaust gases pass or a portion of water from the injector may be diverted to an electrolysis device before injection into the exhaust gases for injecting hydrogen and oxygen into the exhaust gases to further promote conversion of harmful emissions to more desirable compounds.

BRIEF DESCRIPTION OF THE DRAWINGS

[0035] In the accompanying drawings, which illustrate exemplary embodiments of the present invention:

[0036] FIG. 1 is a schematic view of the fertilizer system for extraction of nitrogen compounds and other plant nutrients as it is used in an irrigation system.

[0037] FIG. 2 is a flow chart diagram illustrating the method in which nitrogen and other plant nutrients are extracted from combustion gases in an irrigation system.

[0038] FIG. 3 is a schematic view of the fertilizer system for extraction of nitrogen compounds and other plant nutrients as it is used in plant care equipment driven by an internal combustion engine.

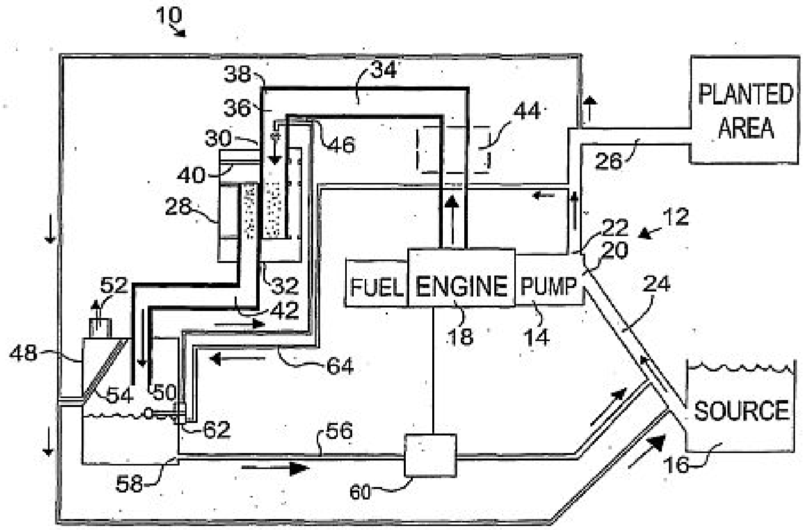

FIG. 1

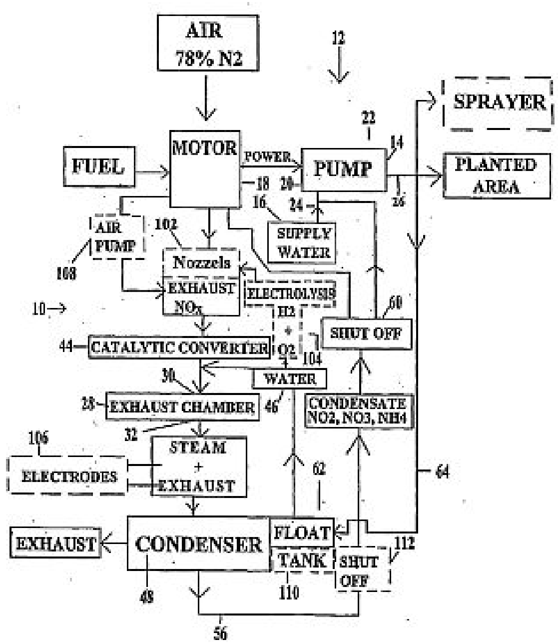

FIG. 2

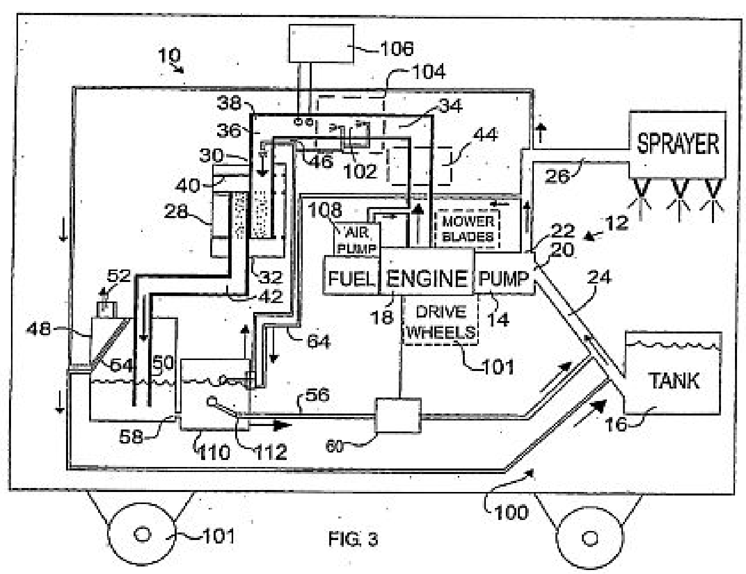

FIG. 3

DETAILED DESCRIPTION

[0039] Referring to the accompanying drawings, there is illustrated a fertilizer system generally indicated by reference numeral 10. The system is particularly suited for as an extraction system for nitrogen compounds and other plant nutrients from combustion exhaust gases. The phrase "nitrogen compounds" is understood in this specification to include any nitrogen related compounds including nitrous oxide (N2O), nitrite (NO2), nitrate (NO3), ammonium (NH4) and other aqueous or non-aqueous compounds containing nitrogen which may be known to have benefits for fertilizing plants. Other nutrients extracted are sulphur, phosphorus, magnesium, zinc, iron, copper and carbon dioxide as a carbonic acid.

[0040] The system 10 includes a pump 14 for pumping water from a source 16 of water used for distributing water to crops and plants. The pump is driven by a motor 18 which typically comprises an internal combustion engine consuming commonly available fossil fuels, for example gasoline, natural gas, propane or diesel fuel and the like.

[0041] While various embodiments are described and illustrated herein, the common features of each will first be described herein. The pump 14 includes an inlet 20 and an outlet 22. The inlet is coupled to a suction line 24 in communication with the water source 16 while the outlet communicates with an outlet pressure line 26 which directs the water to a distribution system for an area to be irrigated or watered.

[0042] The fertilizer system 10 includes an exhaust chamber 28 which is similar in construction to a conventional automotive muffler in the illustrated embodiment. The exhaust chamber is a sealed chamber having an inlet opening 30 at a top end and an outlet opening 32 at a bottom end thereof. An inlet pipe 34 connects the inlet at the top of the exhaust chamber 28 in communication with the exhaust of the motor 18 of the irrigation system. The inlet pipe 34 includes a downwardly extending portion 36 which extends downwardly into the exhaust chamber 28 after an elbow 38 redirecting the inlet pipe from the motor. The exhaust chamber further includes internal baffles 40 which redirect the exhaust passing therethrough from the inlet pipe 34 to an outlet pipe 42 which is axially misaligned with the inlet pipe. As in a conventional automotive muffler the exhaust must pass through various baffles 40 and possibly through perforations in the respective inlet and outlet pipes in order to navigate through the exhaust chamber.

[0043] A catalytic converter 44 is coupled in series with the inlet pipe between the motor 18 and the exhaust chamber 28 so that exhaust gases pass through the catalytic converter prior to entering the exhaust chamber. The catalytic converter acts as a catalyst for the hot exhaust gases from the motor to react some of the compounds within the exhaust gases. The catalytic converter may be removed depending upon the desirable nitrogen compounds which are to be extracted and depending upon the particular application, the type of motor 18 and the type of fuel being consumed.

[0044] A water injector 46 is provided for injecting water into the hot exhaust gases as it enters the exhaust chamber 28. The water injector is coupled to the downwardly extending portion 36 of the inlet pipe to prevent backflow of injected water to the motor 18 of the pump. The water is sprayed into the exhaust chamber for mixing with the hot exhaust gases to be converted to steam before exiting through the outlet pipe. The water injector 46 receives water from the outlet pressure line 26 to which it is coupled so as to receive pressurized water from the pump outlet to be injected into the exhaust chamber by an injector line 64.

[0045] The outlet pipe of the exhaust chamber 28 feeds into a condensing chamber 48 where the mixture of water vapor or steam and hot exhaust gases form condensate in the form of water enriched with nitrogen compounds and other plant nutrients. The condensing chamber 48 generally comprises a barrel or drum having an inlet pipe 50 extending downwardly into the barrel at a top end thereof to which the outlet pipe of the exhaust chamber is coupled. The condensing chamber further includes an exhaust opening 52 at the top end thereof. A condenser core 54 is provided within the condensing chamber which spans the walls of the chamber between the open end of the inlet pipe 50 and the exhaust opening 52. The condenser core includes passages therethrough for circulating a cooling fluid to assist in the condensation process. In the illustrated embodiment the cooling fluid comprises water which is circulated from the outlet pressure line 26.

[0046] A collector line 56 couples to a drain 58 at a bottom end of the condensing chamber. The collector line 56 is coupled at an opposite end to the suction line 24 adjacent the inlet of the pump 14 so that condensate collected from the condensing chamber by the collector line 56 is drawn into the inlet of the pump with the irrigation water from the source 16 to be subsequently distributed by the outlet pressure line to a distribution system.

[0047] A shut-off valve 60 is coupled in series with the collector line 56 between the condensing chamber 48 and the suction line 24 to selectively interrupt flow of condensate through the collector line. The shut-off valve 60 includes a suitable controller for opening the valve 60 only when the pump motor 18 is operating so that the shut-off valve 60 is closed when the motor is not in operation to prevent leakage of condensate into the suction line.

[0048] A float valve 62 is supported within the condensing chamber 48 and is coupled in series with the injector line 64 coupling the water injector to the irrigation pressure line. The float valve is arranged to be opened only when a level of condensate within the condensing chamber falls below a prescribed level so that in the instance when the level falls below the prescribed level, the water injector 46 injects water to raise the condensate level. Once sufficient condensate collects within the condenser above the prescribed level, the float valve 62 closes to prevent further water being injected into the exhaust chamber. The float valve 62 ensures that condensate level remains above the drain 58 and corresponding collector line 56 to prevent air from being drawn into the suction line of the pump.

[0049] The fertilizer system 10 is first started by operating the pump 14 using the pump motor 18. The motor draws in intake air from the surrounding air which is approximately 78% nitrogen in the form N2. The high heat of combustion in combination with the compression and ignition within the engine converts the nitrogen to useable forms of nitrogen compounds, for example nitrous oxides (NOx). The hot exhaust gases exit the motor and pass into the exhaust chamber 28 at which point the water injector 46 sprays water into the hot stream of exhaust gases entering downwardly into the exhaust chamber to form steam in the exhaust chamber which absorbs and collects nitrogen compounds and other plant nutrients from the hot exhaust gases forming various nitrogen compounds in solution with the water vapor. The condensate which then forms in the condensing chamber 48 includes such compounds as NO2, NO3, NH4, sulphur, phosphorus, magnesium, zinc, iron, copper and carbon dioxide as a carbonic acid. As noted above the water level within the condensing chamber is controlled by the float valve to inject water from the outlet pressure line as required to maintain condensate level above the prescribed level. As long as the motor of the pump remains in operation, the shut-off valve 60 remains open so that condensate from the condensing chamber is sucked through the collector line 56 into the suction line 24 of the pump to subsequently fertilize an area, upon which the enriched water is dispersed, with nitrogen compounds and plant nutrients carried by the water. By passing the exhaust through the additional catalytic converter before entering the exhaust chamber, the type or quantity of desirable nitrogen compounds can be increased in the condensate which later forms as different types of exhaust gases are converted as required depending upon the type of combustion device and the type of fuel being combusted.

[0050] The system 10 is particularly useful in combination with or as a retrofit kit for conversion of an agricultural irrigation system 12 or self propelled equipment 100 to enrich water to be fed to the plant material in association therewith while reducing harmful emissions of the engine/motor 18.

[0051] When used in an irrigation system 12, as illustrated in FIG. 1, the engine 18 comprises an existing engine of the irrigation system used to drive the existing pump 14 of the irrigation system for pumping water from a source in the form of irrigation water collected for a crop or plants to be irrigated.

[0052] When used on self propelled equipment 100, as illustrated in FIG. 3, the engine 18 comprises an existing engine of the equipment for propelling or driving the equipment, for example a sprayer or mower engine, which is supported on wheels 101 for rolling movement along the ground. The source 16 of water in this instance comprises a portable tank carried by the equipment or towed by the equipment on a trailer. The destination of the enriched water is a sprayer type distribution system also carried by the equipment 100.

[0053] Turning now to FIG. 3 in greater detail, additional control systems may be included for co-operation with the components noted above with regard to common features of both embodiments. To improve efficiency of the water scrubbing by injector 46, the injector 46 may include a plurality of nozzles 102 at plural spaced positions along the exhaust passage between the engine and the exhaust chamber. The plurality of nozzles serve to inject water at plural spaced positions more evenly and more gradually to ensure more thorough mixing of the products of combustion with the water vapour produced by the heat of the exhaust. Part of the water provided to the injector 46 may also be directed to an electrolysis device 104 which produced hydrogen and oxygen by electrolysis for injection into the exhaust with the water to further aid in the conversion process of nitrous oxides to useful nitrite and nitrate compounds. A set of high voltage electrodes 106 can also be positioned within the exhaust passage extending between the engine and the exhaust chamber to produce to a corona or high voltage arc between the electrodes which provides energy to assist in desirable chemical reactions taking place to promote more favourable products of combustion. An electrical field generator may also be provided which surrounds the exhaust passage. Additional air to assist in the conversion of various nitrous oxide compounds to desirable nitrite, nitrate and ammonia is provided by an air pump 108 also driven by the engine 18.

[0054] To provide more precise control of the fluid levels within the condenser chamber, the condenser chamber may include an auxiliary chamber 110 or may simply be enlarged to house further controls therein. The auxiliary chamber 110 is coupled to the condensate chamber so that levels of condensate are maintained at the same level within each. The float valve 62 can thus be mounted in either chamber in communication with the condensate for similar operation of water passing through the injector line 64 to the injector 46 when condensate levels fall below a prescribed level. An additional float valve 112 is provided in the auxiliary chamber 110 in series with the collector line 56 where the collector line couples to the drain 58 of the condensate chamber to permit condensate to be dispensed into the collector line only when the float valve 112 is opened as a result of condensate levels within the condensate and auxiliary chambers being above a prescribed level. This configuration ensures that in the event of a lack of condensate for whatever reason, the collector line will not draw air into the pump if the pump is permitted to continue operating by the engine 18.

[0055] The system 10 operates on the equipment 100 in a similar manner of operation as the irrigation system by drawing water from a tank carried on the equipment through the pump to a distribution system of the equipment which may comprise sprayer nozzles and the like for dispensing the water onto a field or planted area. The pump is driven by an existing engine 18 of the equipment, for example the engine driving the mower blades or propelling a mower or sprayer for movement across the ground. Water is re-circulated and mixed with the exhaust gases in the manner described above so that desirable nutrients in the form of nitrite, nitrate and ammonium, sulphur, phosphorus, magnesium, zinc, iron, copper and carbon dioxide as a carbonic acid are dispensed to the planted area while harmful emissions in the exhaust gases are reduced.

[0056] In an irrigation system the source of water may comprise a lagoon or the like which feeds water through the system as described above for subsequently being dispersed to the irrigation area. The engine 18 in this instance preferably comprises an existing engine driving the irrigation pump of the irrigation system. In either instance the fertilizer system is preferably operated to run continuously while the engine is running with all of the condensate being fully diverted into the water to be dispersed over the planted area. Only water is preferably added, with air being optionally added to the existing products of combustion of the internal combustion engine 18 to provide a system which is simple to operate which obtains benefits from otherwise harmful and useless products of combustion.

[0057] Further benefits of the use of water injected into an exhaust chamber as described above include the pre-heating of irrigation water and control of emission gases from the combustion device. The addition of water to the exhaust gases is beneficial to the environment because the interaction of water with the hot exhaust gases causes some undesirable emissions to be converted to less harmful compounds that are less damaging to the environment and because the system requires no additional energy consumption other than the use of equipment which would otherwise already be in operation.

[0058] When the water injected into the exhaust chamber comprises irrigation water which is returned to the irrigation pump, the exhaust chamber acts as a heat exchanger to recover waste heat from the exhaust gases to preheat the irrigation water. Preheating the irrigation water is of benefit so that cold source water, for example from a river, provides less thermal shock to irrigated plants which would normally be warmer than the source water.

[0059] While some embodiments of the present invention have been described in the foregoing, it is to be understood that other embodiments are possible within the scope of the invention. The invention is to be considered limited solely by the scope of the appended claims.
