PROJECT NO: FP6-017971

VOLTAIR

A Novel Hybrid Regenerating Filter for Improving Air Quality by Safely Destroying Biologically Active Airborne Particulates in Agri-Food Production Operations

Co-operative Research (Craft)

Horizontal Research Activities Involving SMEs

Final Activity Report
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PROJECT INFORMATION

PROJECT NO: FP6-017971

CONTRACT NO: COOP-CT-2005-017971

TITLE OF PROJECT*:* VOLTAIR – A Novel Hybrid Regenerating Filter for Improving Air Quality by Safely Destroying Biologically Active Airborne Particulates in Agri-Food Production Operations

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SME EXPLOITATION MANAGER: Mr Chris Garner Smith, Filter-One

***SME CONTRACTORS*:**
1 Filter-One
2 Aluhightec
3 PointL
4 Desotec
5 Swisstulle
6 Ashleigh Farms

***OTHER ENTERPRISE / END USER CONTRACTORS*:**
7 Ugine & Alz
8 McDonald's UK

RTD PERFORMER CONTRACTORS:
8 Pera Innovation Ltd
9 TI

Abstract

A new low cost technology that will revolutionize the air filtration industry has been invented by a consortium of EU SMEs. The project funded by the EU has successfully completed the development of a novel self cleaning, high efficiency electrostatic precipitator and activated carbon filter for removal of particulate matter and toxic odour compounds. EU intensive animal farmers, restaurants and manufacturers can benefit from a clean environment and increased production due to improved health.

In a two year EC Craft project called VOLTAIR, the SMEs and researchers have developed a high efficiency, high capacity, self cleaning Electrostatic Precipitator combined with a novel formulation of Coated Activated Carbon to provide clean air quality in the agri-food production and manufacturing sector.

Overview

European SMEs right across the Agri-Food Production and other manufacturing sectors suffer from airborne organic particulates, in the form of ultra-fine dust or smoke, which have adverse biological effects when inhaled. These organic and inorganic emissions, which are generated at all stages - the production of livestock, the manufacture and drying of food, and the preparation of food in restaurants, food service institutions, heavy manufacturing processes, foundries and steel mills - pose a common health threat for a number of reasons:

- Allergenic effects of organic materials ingested
- Nutrient effects of the materials for bacterial growth
- Live Bacterial content of some materials such as animal dusts
- Adsorbed irritants such as ammonia or volatile organic compounds

The EC Craft project, VOLT-AIR was setup to develop a highly efficient system to remove harmful organic or inorganic compounds from the air stream. The consortium being transnational in nature comprises of skilled SMEs and a partnership representing end users in intensive animal farming, commercial food production and steel manufacturing.

Project Objectives

The objective of the VOLT-AIR project was to develop a novel high efficiency, high capacity filter that will both **capture and destroy** any type of active organic particulate or noxious gas. It will remove the material from the air stream, including the ultrafine particles that are increasingly regarded as the most harmful, and render it harmless through an automatic heating and plasma generating step, leaving it inert and ready for disposal, or even ready for automatic in-situ destruction. The technologies used are a novel multi electrode precipitator design and a unique multi functional medium that adsorbs gases and traps large particles, and can be activated by an electric field to produce the plasma.

Current air filters have high capital cost and need regular maintenance. In the restaurants additional maintenance cost is added to clean grease deposits from the extraction ducting due to inefficient filters. Hence the industrial objective of the VOLTAIR system was to develop a low cost high efficient electrostatic precipitator and

regenerative carbon filter. Plasma/Ozone regeneration reduces the activated carbon bed depth and as such provides constant low pressure and reduced filter maintenance cost. The self cleaning capability provides reliability and reduced maintenance cost.

Project Results and Approach

The quality of life, health and safety will be impacted with significant reduction in nuisance emissions of odour and toxic material in both urban and work environment through the developed innovative self cleaning electro filter system. To achieve the objectives of VOLT-AIR, a two year research and development campaign was undertaken under FP6 Craft scheme to advance existing knowledge and overcome project goals.

The key scientific and economic achievements of the VOLT-AIR project are:-

- A high voltage multi electrode electrostatic precipitator and integrated heating system with a residence time of 0.6s:
  - 99.95% efficiency in smoke / particulate removal (~0.3microns)
  - Excellent grease removal through innovative geometric design, Ozone generation and automatic heating
  - Self cleaning mechanism and sterilization through chemical oxidation and automatic heating
- A Coated Activated Carbon neutralisation material in combination with ESP
  - 99% efficiency in the removal of organic odour compounds from pig faeces
  - 82% efficiency in the removal of organic odour compounds from cooking
  - Low pressure loss
- Feedback control emissions monitoring system for online filtering efficiency optimisation, Ozone output control and energy efficiency.

A literature review / analysis of the industrial emissions present in three applications were carried out at the start of the project and validation trials conducted on two applications: pig faeces and commercial cooking.

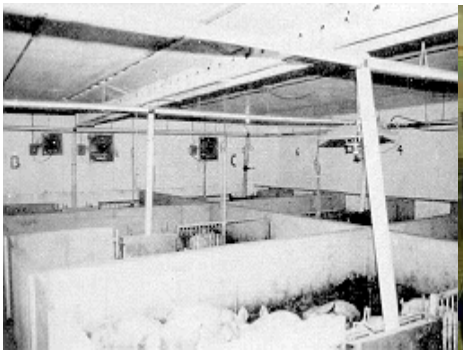


Figure 1a – Pig farm

Figure 1b – Restaurant kitchen

The information gathered was used in the selection of appropriate standard emission tests to aid the development of the Volt-air system.
In addition, specific compounds were identified as a reference for monitoring emission levels and ultimately ensuring optimum removal efficiency. Since the basis of odour perception is psycho-physiological it was difficult to identify a single or small group of compounds as responsible for the sensory reaction. However, our approach was to

identify key odour compounds with major health hazards for which removal will eradicate odour. As such, a low-cost and easily quantifiable measurement system for odour reduction has been developed based on monitoring Ammonia, Hydrogen Sulphide and Ozone. Laboratory characterisation and development of standard odour emission generation for testing abatement systems is problematic. Thus, the real odour removal performance of the VOLT-AIR system was determined at the validation stage.
A prototype was designed and built following required specification from the industry application review and needs.

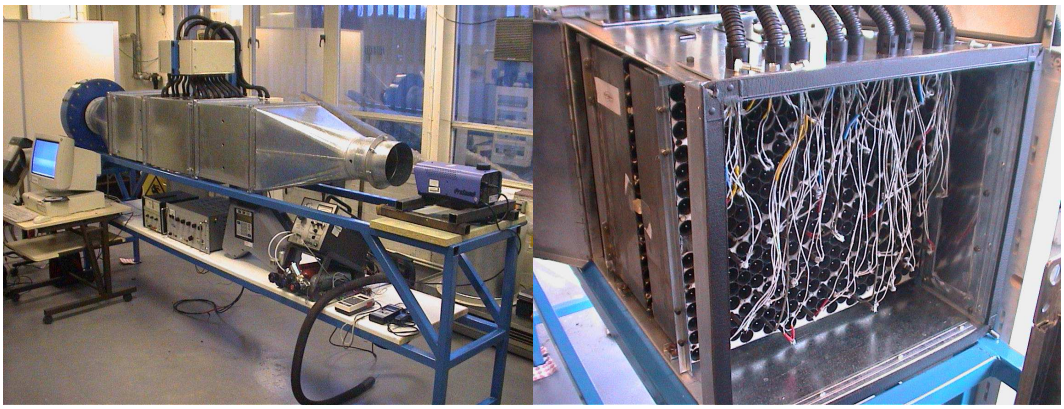


Figure 2 - Optimized curves of relative electrical resistance and stress versus strain

The influence of the relationship between physical and chemical operational parameters was characterised using computational fluid dynamics (CFD).

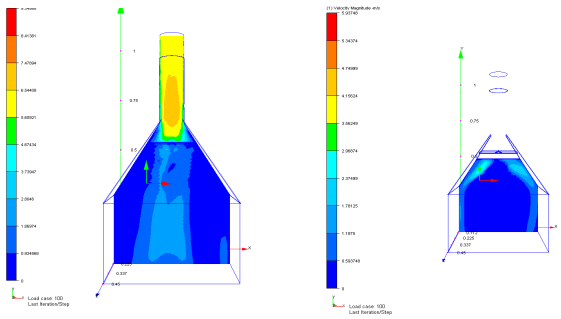
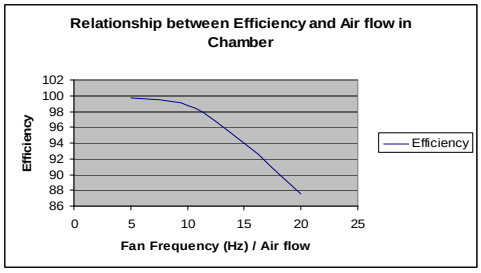


Figure 3 – CFD Model of test rig.

From the CFD analysis, a flow velocity profile regulating mechanism was produced to slow the flow in the centre of a pipe so that the operating electric field has a high enough influence to improve mean particle capture.

Tests carried out to investigate the effectiveness of the filter include: (a) smoke tests to check for leaks, (b) Dispersive Oil Particulate (DOP) Aerosol test for leakage test and photometer detection of efficiency (Figure 4), (c) Ammonia test to determine the effects of the Electrostatic filter plasma on Ammonia.

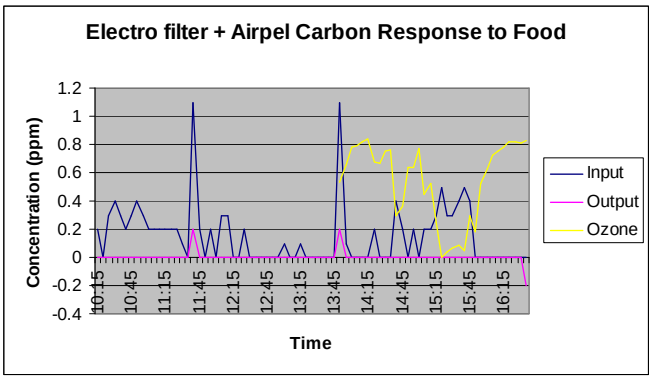


DOP Tests carried out on the Electrostatic Precipitator alone achieved 99.74% efficiency.

Apart from problems with inefficiency in air filtration technology within the EU, the state of the art is plagued by high capital and maintenance cost. Several neutralisation material formulations were considered paying particular attention to minimising the capital cost and reducing service cycle and maintenance cost. Four materials produced by Desotec (Belgium) were specified and designed for testing. They are Airpel, Organoso, KOH coated activated carbon (CAC) and H_2SO_4 CAC.

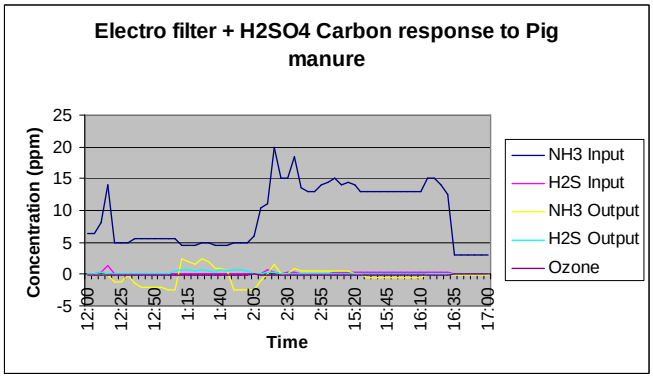
Following laboratory trials and optimisation, a validation testing campaign was designed and set-up to determine the filter performance in the two case study environments. A typical McDonald's vat frying station was built using their facilities and pig faeces from a pig farm used to validate the technology.

Observations from validation trials:



The optimum filter configuration for the food industry emissions is the Electro-filter and Airpel Carbon. It was determined that -3KV was required for optimum efficiency. Also due to varying input emission loading during cooking voltage control is essential. Food odour could not be sensed at the outlet. Removal of grease with the optimised geometric design was successful with only a 5mm penetration into the electro-filter electrode and no deposits upstream or downstream of the filter. Smoke removal was highly efficient.

Unlike the food industry trials - 6KV was required to successfully remove emissions from 150L of pig faeces connected to the input. Determination of best filter configuration was down to odour performance. The electro-filter and H_2SO_4 CAC performed best with 99% NH_3 removal and 38% H_2S removal. Airpel showed good performance with 83% NH_3 removal and 67% H_2S removal.



Similar results to the electronic sensors were recorded in gas chromatography tests undertaken with samples of gas from the upstream and down stream of VOLT-AIR during trials. An efficiency of 91.3% was achieved for the removal of NH3 from pig faeces using the Electro-filter + H_2SO_4 CAC configuration. A 37.5% reduction in H_2S concentration was recorded with the electro-filter only configuration, while a 3.8% reduction was recorded for the electro-filter + H_2SO_4 configuration.

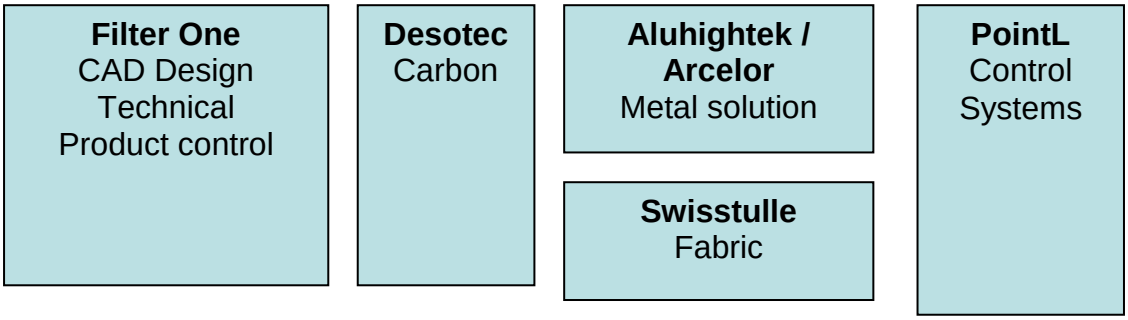
Sterilization in VOLT-AIR is achieved through an automatic heating system and Ozone oxidation process from the high voltage multi electrode layout. The high voltage multi electrode network attracts pollutants carrying bacteria to the plates for destruction. This increases the rate of heat conduction from the filter to bacteria. The heat sterilization which is carried out periodically is combined with sterilization by Ozone which is continuous while the filter is on. With this design a small exposure time is required for the inactivation of pathogens and as such reduced the energy required to run the VOLT-AIR system.

Marketing Plan

Dissemination of results from the project has kicked off and response from a presentation given at a major exhibition in France was good. Fagor Brandt a

subsidiary of Fagor group, the 5th largest European household appliance group has shown increasing interest in the VOLT-AIR technology. The success of the project objectives has been reflected on the interest from end users groups in various industries. This includes McDonald's, Ashleigh farms and Arcelor who are part of the consortium. The SME partners are committed to a robust plan to commercialize the VOLTAIR technology in the agro-food production industry.

The formation of a company called 'VOLT-AIR Worldwide' (VW) has been proposed to the consortium by the exploitation manager. The mission: to maximise value for its shareholders by exploiting all profitable business models worldwide for Voltair solutions / products. The shareholders being: Filter-One (France), Volt-air SMEs, sub contract manufacturers, VW directors and Venture Capitalist (VC). The supply chain is as follows:



A project website has been constructed and can be accessed through www.voltair.eu The website includes a secured forum for online communication between project partners and it also acts as a dissemination and promotion tool of the project to the public.

Conclusions

The SMEs and researchers have invented a high efficiency, self cleaning, low cost multi electrode electrostatic precipitator and neutralization material, for increased environmental quality, health and safety in EU industry. This has been recognized by leading end user companies in various industries which include Ashleigh farms, McDonald's UK, Arcelor and Fagor Brandt.

The SMEs have cooperated successfully on a TransEuropean level and are committed to exploit VOLT-AIR by commercializing the technology in the agro-food production industry.

Acknowledgements

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PROJECT DETAILS

TITLE OF PROJECT:	A Novel Hybrid Regenerating Filter for Improving Air Quality by Safely Destroying Biologically Active Airborne Particulates in Agri-Food Production Operations
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Filter-One UK Ltd	Filter-One	UK
Aluhightec	Aluhightec	Denmark
Destec	Desotec	Belgium
PointL	PointL	Bulgaria
Swisstulle	Swisstulle	UK
Ashleigh farms	Ashleigh farms	Republic of Ireland
Ugine & Arcelor	Ugine & Arcelor	France
Mc Donald's restaurant Ltd	Mc Donald's restaurant Ltd	UK
Technologisk Institutt	Technologisk Institutt	Norway