ENVIRONMENTAL TECHNOLOGY VERIFICATION

ETV Verification Statement

Technology type	UV-C technology for commercial kitchen cooking hoods	
Application	Reduction of grease and oil deposits in hoods and ducts and the emission of particles and odour in ventilation air	
Technology name	JIMCO KPC[1]	
Company	JIMCO A/S	
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DANETV, The Danish Centre for Verification of Climate and Environmental Technologies, undertakes independent tests of environmental technologies and monitoring equipment.

DANETV is a co-operation between five technological service institutes, DHI, Danish Technological Institute, FORCE Technology, Delta and AgroTech. DANETV was established with financial support from the Danish Ministry of Science, Technology and Innovation. Information and DANETV documents are available at www.etv-denmark.com.

The verifications and tests are planned and conducted in accordance with the guidelines for the ETV Scheme currently being established by the European Union.

This verification statement summarizes the results from the ETV test of the JIMCO KPC developed by JIMCO A/S used for reduction of grease and oil deposits in ducts and emission of particles and odour from commercial kitchen cooking hoods.

Descriptions of technology

The JIMCO KPC is based on the effect from ultraviolet radiation in the C band (UV-C), which covers the wavelength range of 10 - 280 nm. The UV-C radiation has a strong germicidal effect on fungi, bacteria and

[1] KPC: Kitchen Pollution Control

viruses, and the technology is widely used in hospitals, health care facilities, and food processing plants, shelters, prisons and other commercial uses, where elimination of biological activity is important.

The effect of UV radiation is commonly known from sunburns, which is caused by the UV radiation in sunlight. It is evident, that UV radiation has a strong effect on organic matter.

The UV-C radiation is produced in special fluorescent tubes made from quartz glass, which is optimized to give the strongest germicidal effect by emitting radiation at 253.7 nm, and also radiation at 185 nm, which produces ozone from the oxygen in the air around the tubes.

The UV radiation at 253.7 nm will attack and break down the organic compounds close to the tubes, and the produced ozone can do the same, but the effect will continue throughout the exhaust system, until all the ozone has reacted, or the air is emitted to the ambient air.

The double bonds in the grease and oil molecules are most likely broken down first, as the double bond sites are more reactive then the single bond sites.

Organic deposits (oil and grease) in the hoods and throughout the whole ventilations system is also attacked by the ozone, and the deposits is claimed to be reduced over a period of time due to ultraviolet photo catalytic oxidation and destruction of the organic deposits.

Figure 1 JIMCO KPC

Application of technology

The intended application of the technology tested is defined in terms of the matrix and the purpose of the technology. The matrix is the type of material that the technology is intended for. Purpose is the measurable property that is affected by the technology and how it is affected.

Matrix	Ventilation air from commercial kitchen cooking hoods
Purpose	Reduction of grease and oil deposits in hoods and ducts and emission of particles and odour

Description of test

The JIMCO KPC application system was tested on a commercial kitchen in Denmark. The test was carried out over a period of 3 months and the main measurements were carried out in three consecutive days.

The commercial kitchen has two deep fry stations beside each other in the left side of the kitchen, the first used for French fries and the second for fish and chicken. On the right side there is a griddle for meat. Each of these three places has its own hood, where the KPC was mounted. On the roof the ducts from the three hoods are connected to one common duct before the fan and the exhaust pipe. The measurements point was placed before the fan.

The test was conducted in the kitchen busy period between 6 PM and 8 PM, and consisted of samples with the KPC alternating on and off. Flow and temperature were measured manually before and after the sampling, and ozone was measured in the duct when sampling samples with the UV turned on. Samples for back ground odour level outside production time was drawn the following morning before start of activities in the kitchen.

Oil and grease deposits will first of all occur in bending where the air changes direction and two inspection doors were mounted in these places. Table 1 shows an overview of the test design.

Table 1 Overview of the test design

Parameter	Unit	Method	Number of test
Odour	OU/m³	Olfactometry	9 sets with and without UV-C
Oil mist	mg/m³	Collection on filters - weighing	2 sets with and without UV-C
Oil mist	mg/m³	Collection on filters – analysis of oil components	2 sets with and without UV-C
Inspection	-	Visual inspection and photos of grease and oil deposits	Inspection of all the hoods in the kitchen after each period (with and without UV-C)
Inspection	Weight/area/time	Removal and weighing of deposit from inspections doors duct wall	After each period (with and without UV-C)

Verification results

This section summarizes the main results of the test and verification as described in the test report and verification report respectively. The result for odour reduction is shown in Table 2.

Table 2 Calculated odour reduction efficiency on average and by 95 % confidence interval

Date (2012)	$C_{raw\ gas}$ OU/m³	$C_{clean\ gas}$ OU/m³
3rd of December	8 400	3 500
	8 700	5 300
4th of December	4 900	2 800
	6 900	3 000
	6 800	3 900
	6 400	3 700
5th of December	4 500	2 000
	5 000	3 300
	5 700	2 800
Odour reduction on average *95 % confidence interval*	**48 %** *34 % to 58 %*	

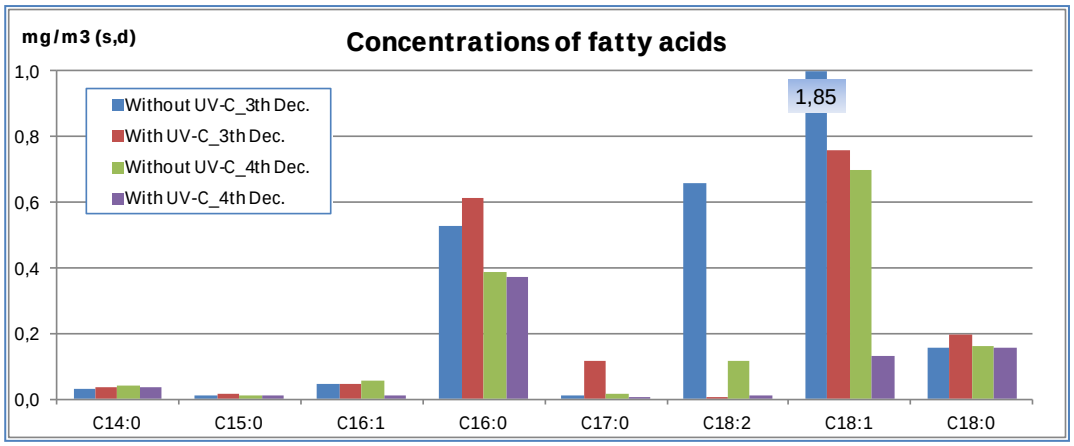
The results for the particle emission and the concentration of fatty acids in the particles are shown in Table 3.

Table 3 Results of the measurement of particles and fatty acids

Date (2012)	UV-C treatment	Particles (mg/m^3)	Fatty acids (mg/m^3)
3rd of December	Off	6.1	3.3
	On	6.6	1.8
4th of December	Off	3.9	1.5
	On	4.2	0.75

The concentrations of particles are increased 7 - 8 % by the UV-C treatment, but there is not sufficient measurement data to document a significant change. The concentration of fatty acids is reduced by 45 – 50 %. It is most likely because of oxidation of fatty acids having one or more double bonds, which can be seen as reduction of the concentration of especially C18:1 and C18:2 in Figure 2 (fatty acid with 18 carbon atoms and one or two double bonds).

Figure 2 Analysis of the fatty acids



The results from the inspection of the hoods and ducts for oil and grease deposits, and the measured deposits on the inspection doors are shown in Figure 3 and Table 4.

Figure 3 Comparison between deposits on the wall behind one set of lamps with and without the UV-C On.

With UV-C for 53 days

Without UV-C for 28 days

With UV-C for 53 days

Without UV-C for 28 days

Table 4 Weight differences of oil and grease depositions on the inspections doors

Inspection door	With UV-C		Without UV-C	
	Days	g/m^2/day	Days	g/m^2/day
Deep fry, pommes frites	53	0.31	28	0.30
Deep fry, other	53	0.90	28	0.59
Grill, west door	53	7.9	28	8.0
Grill, east door	53	3.7	28	2.9

There is no significant reduction of the deposits of oil and grease on the inspection doors from the UV-C treatment.

EVALUATION OF PERFORMANCE PARAMETERS

Performance parameter	Verified performance
Odour	48 % reduction on average
Oil and grease deposits	No significant reductions in the ducts and hoods
Particles	A small but not significant increase in particle concentration was registered with the UV-C on
Fatty acids	A 45 – 50% reduction and some change in the composition was registered

Quality assurance

The test and verification have been performed according to the Centre Quality Manual. As a part of the quality assurance an external technical expert provided review of the planning, conducting and reporting of the verification.

Original signed by Marianne Kyed Ørbæk 14/3 2013
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Verification responsible, FORCE Technology