SUMMARY

K. Boholt: Air Quality with Use of Make-Up Air. Direct fired make-up air can be used in buildings as a replacement of exhausted air and contribute to avoiding drafts and to achieve a comfortable temperature. However, it is important that the polluting influence from combustion products from gas burning do not exceed the total acceptable index of occupational health, $\Sigma\frac{C}{TLV}=1$. Danish investigations show that $\Sigma\frac{C}{TLV}$ between 0.64 and 0.85 can be obtained with carbondioxide (CO_2) and nitrogendioxide (NO_2) contributing with approx. 50%, resp. 25% of the total load.

RESUME

K. Boholt: Qualité de l'Air, Utilisant l'Air Alimenté. Gax chauffé directement peut être utilisé comme remplacement de l'air usagé et contribuer a éviter du trait et a donner une température agréable. Mais il est important que l'influence polluante des produits de la combustion ne pas excède l'index acceptable total pour le milieu de travail, $\Sigma\frac{C}{TLV}=1$. Des recherches danoises ont montrés, que $\Sigma\frac{C}{TLV}$ entre 0.64 et 0.85 peut être obtenu, le dioxyde de carbon (CO_2) et l'azote dioxyde contribuant avec 50%, réspectivement 25% de la charge.

KURZFASSUNG

K. Boholt: Raumluftbeheizung mit Verwendung von Gebrauchter Luft. Raumluftbeheizung mit direktgeheiztem Gas kann in Gebäuden verwendet werden als Ersatz für Luft, die gebraucht ist und dabei Zug vermeiden und eine behagliche Raumtemperatur erreichen. Es ist aber wichtig, dass der verunreinigende Einfluss der Verbrennungsprodukte von der Gasfeuerung den totalen akzeptablen Index für das Arbeitsmilieu, $\Sigma\frac{C}{TLV}=1$, nicht überschreitet. Dänische Untersuchungen zeigen, dass von 0.64 bis 0.85 kann erreicht werden, wozu Kohlendioxid (CO_2) und Stickstoffdioxid (NO_2) mit 50%, bzw. 25% der totalen Belastung beitrugen.

AIR QUALITY WITH USE OF MAKE-UP AIR

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Introduction

Make-Up air is outdoor air which has been heated to a comfortable temperature and introduced into a building to replace air, which has been exhausted.

Make-Up air is not intended to heat the building and should not be confused with space heating, although the distribution of Make-Up air must be coordinated with the space heating system.

However, a number of combustion products are formed through combustion of natural or propane gas and these are alsq sent out into the industrial building.

After Danish legislation the use of direct fired Make-Up air is only allowed if the combustion products make no harmful effects on persons, present in the rooms.

In the worst case of burning of gas the additive effect of all pollutants at the workplace, the socalled acceptindex $\Sigma\frac{C}{TLV}$ should not exceed 1, if the conditions are to be found acceptable.

This study presents the results of an investigation of the pollution from a direct fired gas Make-Up air heating system under different conditions.

Products of gas combustion

By complete combustion of natural gas (or propane) under ideal conditions (optimal proportion between air and gas, good mixing and with a correctly installed burner) the following combustion products, water (H_2O), carbondioxide (CO_2) and nitrogen (N_2) will arise.

Normally other pollutants are formed in traceamounts. These can be hydrocarbons (C_nH_m), nitrogenmonoxide (NO), nitrogenodioxide (NO_2), carbonmonoxide (CO) and odorants (aldehydes). /1,2/.

The normal type of burners in Make-Up air system is specially aimed at minimizing C_nH_m, NO, NO_2 and CO formation whereas CO_2 cannot be avoided. Water Vapour from combustion by direct fired gas Make-Up air may, especially in cold weather, be a very good means of obtaining an appropriate humidity in the air, while indirect heating of Make-Up air may result in an unwanted decrease in the relative humidity.

Legislation

According to the standards of the Danish National Institute of Occupational Health /3/ the combusiton products from direct fired gas Make-Up air heating systems and other pollutants must under the worst operational conditions have no harmfull influence on persons exposed to the Make-Up air. The total additive effect of the polluting components, the acceptindex of occupational health, $\Sigma \frac{C}{TLV}$ must not exceed 1. See table 1.

Table 1: Danish Standards for allowable pollution with use of direct fired gas Make-Up air.

	Treshold limit value TLV		Contribution to pollution
CO_2	5000	ppm	C_1
CO	35	ppm	C_2
NO_2	5	ppm	C_3
NO	25	ppm	C_4
The acceptindex: $\Sigma \frac{C}{TLV} < 1$			

In table 2 are shown standards from other countries.

Table 2: Standards for allowable pollution from direct fired gas Make-Up air from different countries.

		West Germany /5/	France /4/	USA*
CO_2	ppm	2200	2200	5000
CO	ppm	10	10	50
NO_x	ppm	-	1	-
NO_2	ppm	1	-	-
Formaldehyd	ppm	-	1	-

Belgium /6/

$$\frac{CO_2}{5000} + \frac{CO}{50} + \frac{NO_2}{5} + \frac{HCHO}{2} + \frac{SO_2}{5} \leq 1 \text{ and}$$

$$\frac{CO_2}{5000} + \frac{NO_2}{5} \leq 0,8$$

* Maximum concentration values for continous 8 hour exposure.

Measurement on a Make-Up air heating system

On a Danish factory which makes aluminium profiles is installed a direct fired gas Make-Up air heating system. Approx 20.000 Nm^3/h heated air were injected. Gas consumption was maximum approx. 20 m^3/h propane gas.

Continous measurements of CO, CO_2, NO, NO_2 and total hydrocarbon (C_nH_m) were carried out in the distribution duct shown on fig. 1.

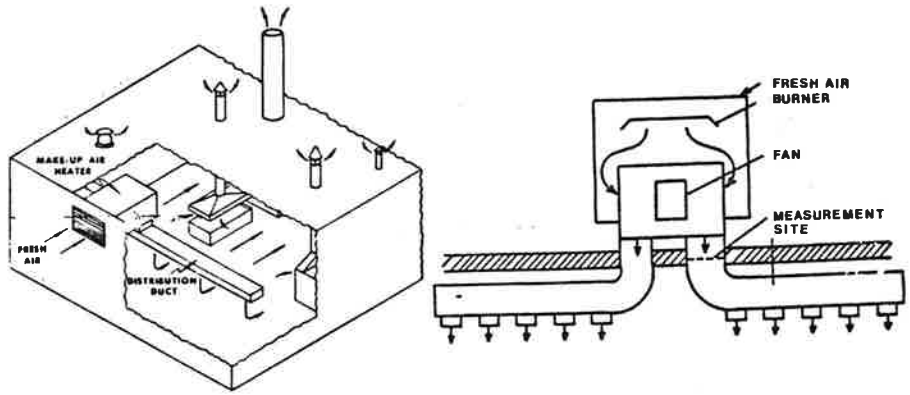

Fig. 1. Left figure shows a sketch of the factory; to the right a sketch of the Make-Up air heating system is found.

To demonstrate the influence of the burners' modulation on the pollution concentrations, the measurements were continued over 2 days.

Results

In table 2 the main resultats of the investigations are shown.

Table 2: Pollants concentration from af direct fired gas Make-Up air heating system on a Danish factory.

		1. day		2. day	
		1	2	1	2
CO	ppm	8	6	5	4
CO_2	ppm	1800	2050	1900	1750
NO	ppm	0,14	0,54	0,34	0,40
NO_2	ppm	1,14	0,94	0,96	0,74
C_nH_m	ppm (CH_4)	39	42	42	41
Total acceptindex, $\Sigma \frac{C}{TLV}$		0,85	0,81	0,74	0,64

The results show that the total hydrocarbon level was relatively high and it is in this case calculated as unburned propane gas. The acceptindex $\Sigma \frac{C}{TLV}$ was at first relatively high, problably due to poor regulation of burners. Consequently, the gas/air mixing was not optimal. After regulating the burner, the NO_2-concentration decreased.

From the results it can be seen that the contributions from CO_2 and NO_2 result in approx. 50%, respectively 25% of the total acceptindex.

Conclusions

By the use of direct fired gas Make-Up air various combustion products such as carbondioxide (CO_2), carbonmonoxide (CO), nitrogen oxides ($NO + NO_2$) and hydrocarbons (C_nH_m) are sent out into the building.

Investigations on a Danish facotry has shown that the additive effect of the pollutants, the total acceptindex $\Sigma \frac{C}{TLV}$ was 0.64 to 0.85.

This means that according to Danish legislation, the conditions were acceptable because the total acceptindex did not exceed 1.

In other countries there are different standards for allowable pollution from direct fired gas Make-Up air.

References

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