A SURVEY OF VENTILATION SYSTEM IN DOMESTIC KITCHENS

by

ISHWAR CHAND AND P.K. BHARGAVA

Scientists, Central Building Research Institute, Roorkee (U.P.)

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A-15, Pamposh Enclave, New Delhi-110 048

Telephone : 635503

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Abstract :

The paper describes findings of ventilation survey conducted in kitchens of various categories of houses in Delhi, Roorkee and nearby areas. The ventilation systems in common use in domestic kitchens and their effectiveness, especially in respect of smoke extraction have been discussed. It is found that, except in the case of a few high income group houses where small fans are in use for inducing air motion for thermal comfort, reliance is usually placed on natural ventilation. The large variations observed in the sizes and shapes of wall openings, hoods and flues, indicate absence of any standard pattern in design. Chimneys are either absent or ineffective for want of a rational design. The availability of only a small pressure head in the kitchen chimney calls for a scientific basis of kitchen chimney design for effective performance.

Introduction :

Extensive research carried out in the field of natural ventilation in this country[1-3] as also abroad[4-6] has placed the science of ventilation design of normal habitats on a sound footing. The main consideration in the ventilation design of houses in tropics had been the provision of comfortable conditions in living spaces. However, attention of a few workers abroad[7-9] was also drawn to problems relating to kitchen ventilation. The problem-studies are typical of the living habits, cooking practice and climatic conditions of the countries concerned. The ventilation systems employed are mostly of forced type. Such data find only limited application in the context of the socio-economic conditions prevailing in this country. Thus there is a need to evolve design standards to meet the ventilation requirements typical to Indian domestic kitchens. To accomplish this, it was imperative to study the design details and evaluate the performance of ventilation systems commonly in use in the existing kitchens. Inherent in this study was also the need to indentify the problems of users and the parameters responsible for inefficient functioning of existing ventilation systems. With this in view, a survey was conducted in kitchens of various types of houses in Delhi, Roorkee and nearby areas. The findings of the study are reported in this paper.

Scope of the Survey

The survey covered a vast spectrum of houses

extending from type I to type V. Selection of houses was made in a manner such that conditions prevailing in houses of all income groups and living habits could be examined. Data were collected on the size of the kitchens, design details of ventilation openings like windows and ventilators, and their location in relation to the other parts of the building. Provision of chimney. size of hood and its height above the working platform, size of flue and its projections above the roof were also noted. To assess the magnitude of thermal force, temperature gradient was also determined in a few chimneys. Furthermore, reaction of users and the problem encountered by them in reference to kitchen ventilation were also recorded. The results are summarised in Table 1.

Sizes of Kitchens

The sizes of kitchens vary from 3.5 m^2 in type I houses to 1.1 m^2 in type V houses. It is also noted that houses older than a decade (S.No. 2 to 6 and 8 to 12) have kitchens larger than the newly constructed houses. In recently constructed houses (S.No. 13 to 16) the area of the kitchen is around 3.5 m^2 and 5.0 m^2 in houses of type I and V respectively. For other categories of houses the kitchen size is about 4 m^2.

Details of ventilation openings in walls

Provision of windows and ventilators is a common and simple mode of inducing ventilation in domestic kitchens. However, the door, usually kept open during cooking hours also acts as a ventilation opening. The total area of such openings is found to vary from 25 per cent to 85 per cent of the floor area. But in recent houses (S.No. 13 to 16) the common trend is to provide opening size greater than 50 per cent of floor area. It was also seen that in low income group houses window is provided only on one wall, whereas in high income group houses, two or even more walls have windows. The area of wall opening does not seem to have any particular bearing on the category of the house. Ventilators have been in use, in old kitchens but now-a-days the kitchens are devoid of any such provision.

Details of mechanical system of ventilation

Exhaust fans have no where been found in use for extraction of cooking odours or smoke from kitchens. However, in a few high income group houses, wall mounted air circulators were found in use for inducing air motion for thermal comfort of house wives. By and large, the ventilation system has to rely on natural forces for its operation.

Details of chimneys

Chimneys constructed in masonry have been provided in almost all types of old houses. Presently, these are built only in low cost houses, and are seldom provided in higher categories of houses. Chimney broadly consists of two parts, viz. the hood and the flue. The width and length of the base of the hood respectively vary from 0.6 m and 0.4 m in type I houses to 2.5 and 0.6 m in type V houses. The shape of the hood is usually like a frustum of a pyramid with inclination of slant surface with vertical varying from 45° to 90°. Hoods with flat top (in the form of inverted sinks) are also provided in some of the houses. The height of the hood above the work plane varies from 0.8 m to 1.0 m. The flues are with square, rectangular or circular cross sections having area as much as 0.18 m^2 (S.No. 6). In some cases ordinary A.C. pipes with 0.10 m diameter are also used to function like a flue. These are projected 0.36 m to 2.2 m above the roof of the house. In several cases a simple hole with 0.15 m (S.No. 10) diameter has been provided in the roof without any flue or hood for extraction of smoke and fumes.

Air motion and temperature inside the kitchens

The measurements of indoor wind speeds in the working zone of kitchens were made for several directions and speeds of outdoor wind. It was found that air indoors is usually calm and velocities above 0.3 m/sec. are rarely induced with outdoor winds of 1.5 m/sec. During normal cooking hours air temperature inside the kitchen was 1°C and 4°C above the outside air temperature in summer and winter seasons respectively. It was observed that average temperatures inside the chimneys were generally 10°C, 12°C & 15°C higher than the outside in summer, rainy and winter seasons respectively. This temperature difference induces the necessary motive force for the movement of gases through the chimney. Obviously, the pressure head is minimum in summer and for a flue with height H(m) the corresponding head is about 0.376 H (N/m^2).

Observations and discussion

Data have been collected on the size of kitchens, area and location of wall openings, size and shape of hoods and their height above the cooking platform, and size of flues and their height above the roof. Large variations found in the design details indicate absence of any standard practice followed in the design of ventilating systems ; apparently all the parameters, except the height of the hood above the cooking platform seem to have

been chosen just arbitrarily. Provision of chimneys was no doubt made in old houses but due to their inefficient functioning these have been discarded in newly built houses. Kitchens profusely adorned with windows but devoid of chimney, specially in low income group houses, suffer from accumulation of smoke in them as also in the adjacent rooms. Cooking odours may not be harmfful but their spreading to living spaces may not be desirable. As such, provision of chimneys of appropriate design is considered to be a definite advantage.

Rational Design of Chimney

Keeping this in view the requirements of ventilation, scientific studies on design of chimneys for extraction of smoke from domestic kitchens were undertaken and an optimum design evolved. The chimney of optimised design [10-11] consists of a quarter conical hood (for chullahs located in the corner) with radius of base equal to 0.65 m and angle of apex 60°. A 0.21 m diameter pipe is mounted on the hood and projected 0.9 m above the roof. A smoothly plastered masonry duct with 0.23 x 0.23 m^2 in cross-section may also be used in place of the pipe. To prevent the entry of driving rain into the chimney, a cap with base diameter 0.31 m is mounted 0.10 m above the pipe. Two chimneys of optimised design, one made of G.I. sheet and the other of masonry structure have been fitted in kitchens of type I houses of CBRI colony. The performance of the chimneys were found quite satisfactory.

Conclusions :

1. Air motion in kitchens is usually too small to meet the comfort requirements of summer and rainy seasons.
2. Reliance is generally made on natural ventlation and only in high income group houses, that too very rarely, small wall mounted fans are used for the thermal comfort of house wives.
3. Provision of large wall openings does not necessarily result in good ventilation.
4. Cooking odours spread to the rooms adjoining the kitchen.
5. Most of the chimneys in use in domestic kitchens are not effective in extraction of smoke as their design is not based on scientific principles.
6. Falling of soot, dust, lizards etc. through the chimneys are the common problems faced by users.
7. The pressure head normally available in kitchen chimneys with 3 m height is about 1.128 N/m^2.
8. The preferable height of hood above the cooking platform varies from 0.8 to 1.0 m.
9. Chimneys as per design discussed in the text ensure the total extraction of smoke from the kitchens.

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References

1. Ishwar Chand & P.K. Bhargava, "Natural Ventilation of Buildings" Monograph, Central Building Research Institute, Roorkee, 1977.
2. Ishwar Chand, "Prediction of Air Movement in Buildings" Building Digest No. 100, Central Building Research Institute, Roorkee, 1972.
3. Ishwar Chand & P.K. Bhargava, "Guidelines for Designing Airy Buildings", Building Digest No. 121, Central Building Research Istitute, Roorkee, 1976.
4. B. Givoni, "Basic Study of Ventilation Problems in Housing in Hot Countries", Research Report to the Ford Foundation, BRS, Techinion Haifa, 1962.
5. B. Givoni, "Ventilation Problem in Hot Countries". Research Report to the Ford Foundation, B.R.S. Techinion, Haifa, 1968.
6. "Chimneys and Draft Calculations", Heating Ventilating Air conditioning Guide 1960.
7. N.S. Billington, "Ventilation of Home Kitchens", The Heating & Ventilating Research Association, Laboratory Report No. 66 July 1971.
8. J.F, Van Straaten, "Some Practical Aspects of Kitchen Ventilation", Bulletin No. 17, National Building Research Institute, Feb. 1959. Council for Scientific & Industrial Research, Pretoria.
9. W. Schule & H. Schacke, "The Ventilation of Kitchens, J.I.H.V.E., Jan. 58, Vol. 25.
10. Ishwar Chand, T.N. Gupta & P.K. Bhargava "Chimny Design for Domestic Kitchens" CBRI Technical Note No. 18, August 1981.
11. Ishwar Chand, Trijugi Nath Gupta Aur Nathi Lal "Ghareloo Pradushan Rokne Haitu Sasti Chimney" (In Hindi) Vigyan Pragati, April 1981.

Table-I

S. No.	Type of house	Year of const.	Size of kitchens	Area of wall openings (% of floorarea	Datails of chimneys			Observations.
					Area of cros section of the flue (% of floor area)	Size of hood	Height of chimney above roof.	
1	II	1972	2.0×1.75×3 m	56%	3%	0.60×0.45 m	2.2 m	Uncomfortable
2	I	1960	2.0×2.0×3 m	70%	4%	No hood	1.1 m	Smoke spreads in adjoining room.
3	II	1960	2.3×1.9×3 m	85%	3%	No hood	0.35 m	Spreading of fumes in kitchen & verandah
4	II	1955	2.55×2×3 m	45%	3%	No hood	1.1 m	Uncomfortable and fumes spread.
5	III	1965	2.14×2×3.1 m	45%	2.5%	1.1×0.40	0.75 m	No problem.
6	III	1958	4.1×2.4×3.3 m	25%	1.85%	1.04×0.60 m	0.75 m	Spreading of smoke in kitchen
7	III	1972	2.14×2×3.07 m	55%	1.85%	1.15×0.45 m	0.6 m	Spreading of fumes in adjoining room.
8	IV	1965	2.5×2.2×3 m	60%	2.5%	1.25×0.6 m	2.2 m	Spreading of fumes
9	IV	1958	4×3.7×3.1 m	40%	1%	0.75×0.5 m	0.36 m	No problem
10	IV	1958	3.3×2.1×3.1 m	70%	0.24%	1.0×0.55 m	0.30 m	Uncomfortable and spreading of fumes in rooms.
11	V	1960	4.7×2.35×3.0 m	28%	1.0%	No hood	0.36 m	No problem
12	V	1960	2.15×2.5×2.9 m	65%	1.7%	2.15×0.5 m	2.1 m	No problem
13	I	1980	2.2×1.6×3 m	55.6%	0.9%	1.30×.40 m	—	Spreading of fumes
14	II	1980	1.82×2.20×3 m	58%	Nil	No hood	—	Spreading of fumes
15	III	1979	1.50×2.70×3 m	58%	Nil	No hood	—	Spreading of fumes. Chimney must be used.
16	IV	1979	2.0×2.55×3.0 m	54.3%	Nil	No hood	—	No problem