Ducts without tears

Blown away

Peter Mason of Blue Flame Associates Ltd looks at fan dilution flue systems and their requirements.

Imagine the problem. You have to route a 600mm chimney up the outside of a building. Unsurprisingly, the architect is against the idea and so is the client. Is there an alternative? Yes: run the chimney through the central core of the building and terminate at high level. An easy solution on paper, but fraught with difficulties unless specific provision for the chimney was made at the building design stage!

There is another solution: take fresh air from low level, mix it with the products of combustion and blow it all out at low level. Simple? Not quite but the principle seems okay.

The theory is fairly straightforward, now think about the practicalities. Put an inlet grille on an outside wall, connect it to a silencer with some ductwork, turn the duct through 90º, connect the appliance chimneys, fit a fan, turn the duct through 90º again, through an attenuator (to further reduce duct noise) and out through another grille to fresh air.

Right, let's review the rules

The 3rd Edition of the 1956 Clean Air Act, Chimney Heights Memorandum states that the termination of any chimney or flue shall be in clear air and not cause a nuisance. If we can dilute the products of combustion (POC) to the maximum concentrations stipulated by Standards, we could discharge at low level, the only stipulation being the need to advise the local Environmental Health Officer (EHO) of the proposed installation.

There are two main Standards which cover the installation of fan dilution systems:

- British Standard (BS) 6644: 2005 + A1: 2008: *Specification for the installation of gas fired hot water boilers of rated inputs between 70kW (net) and 1.8MW (net) (2nd and 3rd family gases)*; and
- Institution of Gas Engineers and Managers (IGEM) IGE/UP/10 (Edition 3) *Installation of flued gas appliances in industrial and commercial premises*.

If the total heat input is no greater than 1MW (gross), the lower edge of the exhaust grille needs to be at least 2m above the ground, any more than 1MW (gross) and this height increases to 3m. If the total heat input exceeds 6MW, the installation cannot occur, although there is no technical explanation offered as to why.

The exhaust grille needs to be in an area where POC can easily disperse, i.e. they should not gather or collect in the locality of the discharge. Unlike ventilation grilles, the louvres normally direct the flow of products upwards at about 30º from the horizontal so that they do not affect people standing around or passing the grille.

The grille needs to prevent rain, snow and leaves from entering the duct. The exhaust grille is required to be a sufficient distance from re-entry points such as doors, windows and inlet ventilation openings, information to enable the calculation of these distances may be found in IGE/UP/10 (Edition 3) or BS 6644.

The dilution system

The preferred method of fan dilution is to introduce dilution air direct from outside into a duct system and to exhaust on the same wall, minimising any pressure differential between inlet and outlet louvres.

This method requires no additional boiler room ventilation to that provided for combustion, cooling and flue dilution via a flue break as normal. The ductwork does not have the high temperature characteristics associated with a 'standard' chimney system; remember it will be cooled with lots of fresh air.

An alternative method (not recommended by Standards) is to take dilution air from the boiler room, mix it with POC and to discharge the mixture through an exhaust grille. This requires a massive amount of additional ventilation direct from outside to replace the air drawn into the flue system and IGE/UP/10 (Edition 3) needs to be consulted if this non-recommended method is to be pursued.

The conventional fan dilution system employs a duct and grille velocity of between 6 and 8m/s. There is a simple method of calculating the capacity of the dilution system based on the net rated heat input of the plant involved. The formula is as follows:

$$\text{Volume flow rate (Q)} = \frac{\text{Fn} \times \text{rated heat input (net) kW}}{3600}$$

Where
Q = volume flow rate in m/s
Fn = fan dilution factor
(10.8 for natural gas, 12.8 for LPG)

Example:
This means that for a 650kW installation the fan flow rate should be:

$$Q = \frac{10.8 \times 650}{3600} = 1.95\,m^3/s$$

Based on a duct/grille velocity of say 7m/s, the installation would require a duct free area of at least:

$$\frac{1.95}{7} = 0.28m^2$$

This would need a circular duct of diameter 600mm

Products of combustion

The concentrations of POC at the outlet or exhaust grilles should not exceed the following maximum design factors:

- CO_2 – 1% above ambient
- CO – 50ppm (parts per million) above ambient
- NO_X – 5ppm above ambient.

Flue gas analysis should be carried out at the extract grille and in the primary flue of each connected appliance chimney system, or as required by manufacturer's instructions.

Fan Dilution – Case study installation

The following 3 photographs were kindly provided by A1 Bridge Flue Systems and show a complicated fan dilution system they installed. The high efficiency boilers will be working in condensing mode supplying the hot water to under floor heating systems.

Photographs **1** and **2** (left) show the internal flue system. When the boilers are firing the fans are controlled by inverters that regulate their speed relative to the numbers of boilers firing. This was done, not only for the energy saving benefits but because the actual concentration of condensate in the system needed to be considered.

Photograph **3** (right) shows the discharge position. It should be noted planning permission had to be gained and that the requirements of IGEM/UP/10 and BS6644 could not be met. As a result of this a system design verification notice had to be issued confirming the design in accordance with IGEM/UP/10.

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Other factors to consider

Unlike common chimney systems, a mix of atmospheric and forced draught appliances may be connected to a fan dilution system, the only requirement being that if no draught diverter is fitted, a draught stabiliser needs to be included (all connected appliances need a flue break).

If all appliances are of the direct flue connection type, a single draught stabiliser may be fitted to the system on the suction side of the fan.

Condensing appliances may be connected to fan dilution systems along with conventional appliances, however the need for water-tight duct-work, the corrosive nature of the condensate (which needs to be collected and transported to a drain) and the increased problems associated with pluming of the discharge must be considered. Fan dilution systems may only be used with very low sulphur (VLS) fuel appliances and this may mean that oil/gas dual fuel burners are unsuitable for connection.

A damper is required on the inlet of the system after the attenuator to control the amount of dilution air being drawn into the system. Each appliance connected to the system also requires a damper to enable the correct draught through the appliance to be correctly set upon commissioning. All dampers need to be locked in position.

As with any powered flue system, according to the Gas Safety (Installation and Use) Regulations 1998 (GSIUR), all the appliances need to be interlocked both with the fan motor (through an auxiliary contactor or a current sensing control system) and with a pressure differential or air movement sensor, thus proving fan operation and draught.

The use of fan dilution systems is not confined to low level installations or building boiler rooms. Packaged boiler rooms and rooftop installations benefit from an aesthetic and practical aspect, i.e. no chimneys sticking through the roof, the reduction of the plume effect associated with conventional flue outlets and the advantage of pre-tested fit-and-forget solutions with the plant assembled off-site.

The design and the installation of fan dilution systems are specialist activities best entrusted to contractors who have the necessary competence and importantly, experience.

In addition to the factors detailed above, variations in air density according to ambient temperature changes, the efficiency of connected appliances and therefore the flue gas temperature need to be considered at the system design stage.

Consideration should also be given to the suitability of appliances for connection to fan dilution systems.

TO SUM UP

- Fan dilution systems can only be used with VLS appliances.
- Fan dilution systems can be a solution where the provision of a full building height chimney is impractical.
- The discharge needs to occur in an area where POCs will not accumulate.
- The design and installation should be entrusted to competent contractors.