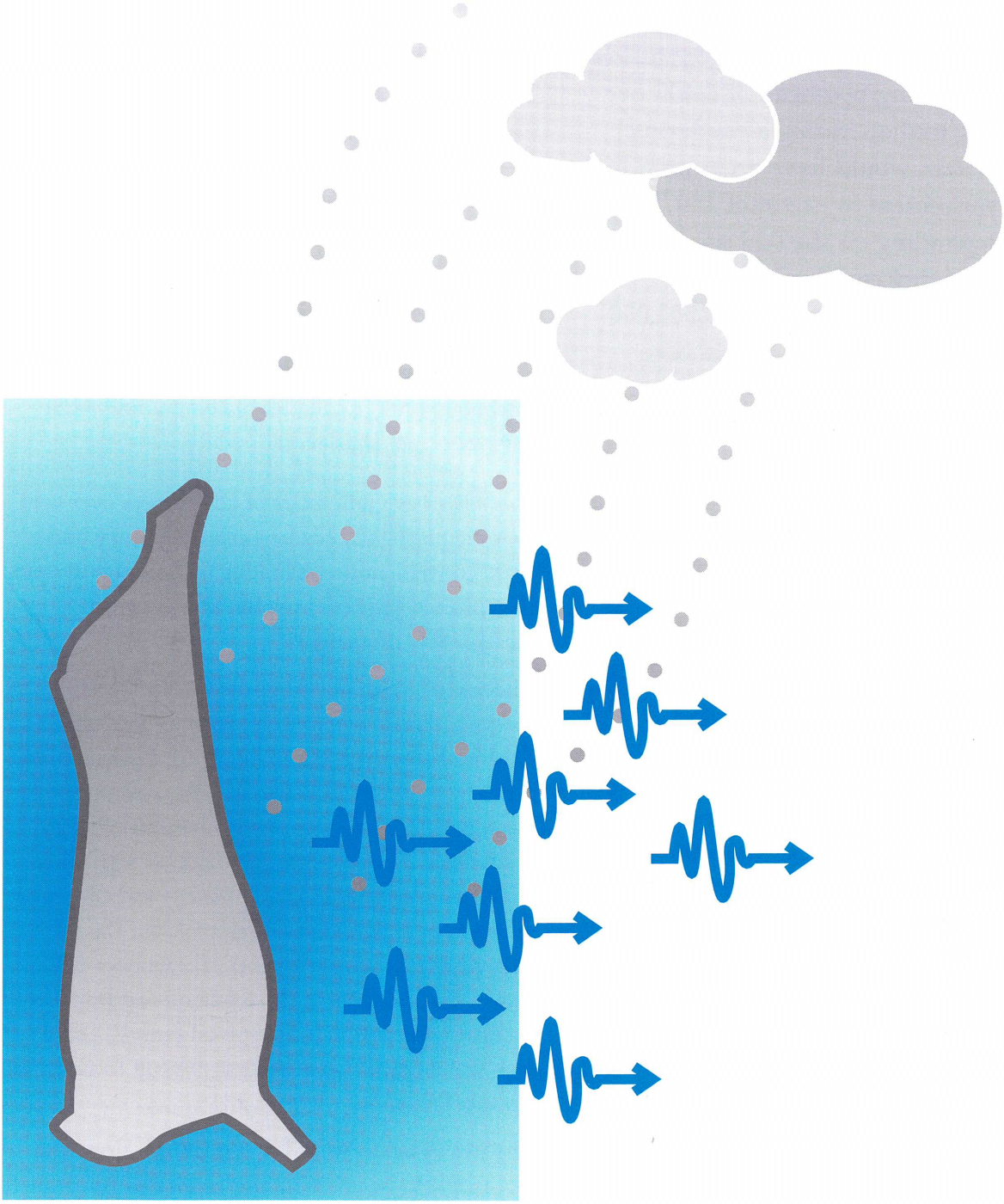


Boiler Fuels

1997

Meat Research Corporation

AMT
AUSTRALIAN MEAT TECHNOLOGY

A typical meat processing operation processing 600 head of cattle per day and operating a rendering system would have an annual fuel energy requirement in excess of 150 TJ (10^{12}J). Depending on the fuel used, the cost of this energy could range from around $500,000 to more than $3,000,000 per annum. In an industry where cost pressures are ever present, such a range of costs justifies a close examination of fuel use.

All fuels have advantages and disadvantages to their use, and all fuels are in use in the meat processing industry. However, in most cases the choice of fuel will be limited by the range of fuels available in a particular region.

Coal is generally the cheapest fuel on an energy basis but not all processors have access to a convenient coal supply. The use of natural gas is growing; however its availability is limited by the location of distribution pipelines. A few processors located in remote regions, where the transport cost of fuels is high, have used tallow as a fuel. Some processors located in regions having a local timber processing industry are using wood waste as a fuel. Fuel oils are available in all regions, but their costs can be high due to government excise and transport costs. In a number of plants, use has been made of waste oils from the motor vehicle service industry.

Whatever fuel is used, consideration must be given to its likely impact on the environment and steps taken to mitigate all unfavourable impacts. The emission of greenhouse gases, mainly carbon dioxide (CO_2) associated with the combustion of all fuels, is of growing concern. The solution is to reduce the emissions of greenhouse gases. It has been suggested by some that the only way of addressing this concern is to reduce fuel use by means of a carbon tax levied on all fuels. The preferred alternative approach is for industry to voluntarily reduce emissions by increased efficiency.

For the meat processing industry to reduce emissions consideration will be required, not only of the boiler operations but also of all processing operations using steam, as fuel use is ultimately dependent on the most efficient use of the steam generated.

Advantages and Disadvantages of Various Fuels

Coal has the major advantage of being the lowest-cost fuel available and, where conditions allow its use, must be seriously considered. The major disadvantages of coal are the lesser overall boiler efficiency, the need to carefully consider the handling and storage of the coal and the handling, storage and disposal of ash. Also, coal requires a greater treatment of the flue gases prior to discharge to ensure that they comply fully with environmental legislation.

Fuel Oils have a number of advantages over coal, including a slightly higher boiler efficiency and a more convenient fuel handling and storage system. Compliance with environmental legislation presents few problems.

The use of waste oils from the motor vehicle service industry as a fuel should only be considered if the lead content is acceptable to the Environmental Protection Authority. This must be guaranteed by the supplier, but it is the **user's** responsibility to ensure that emissions comply with all regulations. Waste oil is exactly that – a waste – and care must be taken to ensure that it is suitable for the oil-burning equipment to be used. Experience has shown that residues in the waste oil can result in excessive damage to gear-type oil pumps, and a high water content can make it difficult to maintain a stable flame.

The use of tallow as a fuel is possible. However, care needs to be taken to ensure that all tallow fuel lines are heated. Starting up and shutting down the combustion equipment on light fuel oil is recommended.

Natural Gas has one major disadvantage: gaining access to the gas supply at a reasonable cost for the connection. Natural gas has a number of advantages, including the absence of on-site fuel storage, simplicity of fuel-burning equipment and controls, high combustion efficiency, suitability for direct firing of product dryers, and the least environmental impact of all generally available fuels.

Energy Content and Cost of Fuels

The heat energy in a fuel is released by the reaction of oxygen with inflammable elements at a temperature above the ignition temperature of the

fuel. The approximate energy contents of various fuels are:

black coal	24 to 29MJ per kg
natural gas	36 to 41MJ per m^3
heavy fuel oil	40 to 41MJ per litre, 43 to 44MJ per kg
light distillate	38 to 39MJ per litre, 45 to 46MJ per kg

The cost per MJ of energy in the above fuels based on the nominated* fuel costs would be:

black coal	$45 per tonne	0.19 cents per MJ
natural gas	$7 per GJ	0.70 cents per MJ
heavy fuel oil	$300 per tonne **	0.69 cents per MJ
light distillate	$280 per tonne ***	0.62 cents per MJ

* fuel costs vary widely depending on plant location, and energy costs should be determined for local fuel prices

** includes duty on heavy fuel oil of around $75 per tonne

***assumes 100 percent repayment of duty on light fuel oil at 34.74 cents per litre.

Boiler Overall Efficiencies

The overall boiler efficiency is mainly determined by the energy loss in the flue gas discharged to atmosphere. Other lesser energy losses occur from the boiler structure due to radiation, and in the boiler blowdown water. In coal-fired boilers, another energy loss is in the unburned coal discharged with the ash from the combustion chamber. Approximate overall boiler efficiencies for different fuels are:

coal	76%
natural gas	80%
fuel oils	79%

The energy loss in the flue gas is determined by combustion conditions. Knowing the chemical structure of each fuel, it is possible to calculate the theoretical (minimum) quantity of air needed for combustion. However, using the theoretical quantity of air, it is extremely difficult to ensure complete combustion and additional air is needed. The quantity of additional (excess) air must be tightly controlled to minimise the loss in the flue gas.

The excess air in the flue gas can be obtained by measuring either the oxygen (O_2) or CO_2 levels in the flue gas which, combined with the flue gas temperature, allows the flue gas losses to be determined. The relationship between O2 or CO_2, flue gas temperature and losses, is different for each type of fuel and can be supplied by the boiler manufacturer or the fuel supplier. Figure 1 indicates the flue gas losses for heavy fuel oil, based on CO_2 and flue gas temperature. Similar information for natural gas, based on O_2 and CO_2, is indicated in Figure 2. The O_2 and CO_2 levels that can be maintained in steam boilers are indicated in Figure 3. The levels indicated were those set and generally achieved by a former major meat processing company in the operation of all of its boiler plants in Australia and New Zealand.

FIGURE 1 Percentage Heat Losses at Various CO_2 Levels for a Range of Flue Gas Temperatures for HEAVY FUEL OIL (source: 'Boiler Management and Steam Utilisation', B.E. Todd 1983, in *CSIRO Seminar Proceedings, Energy Management for the Meat Industry,* 1983)

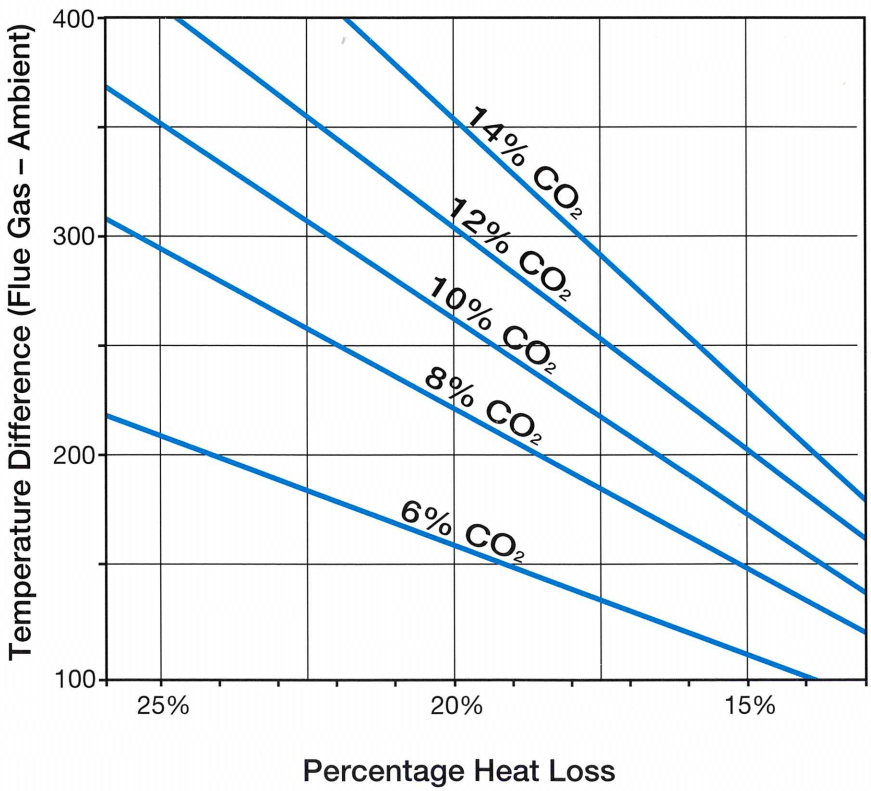
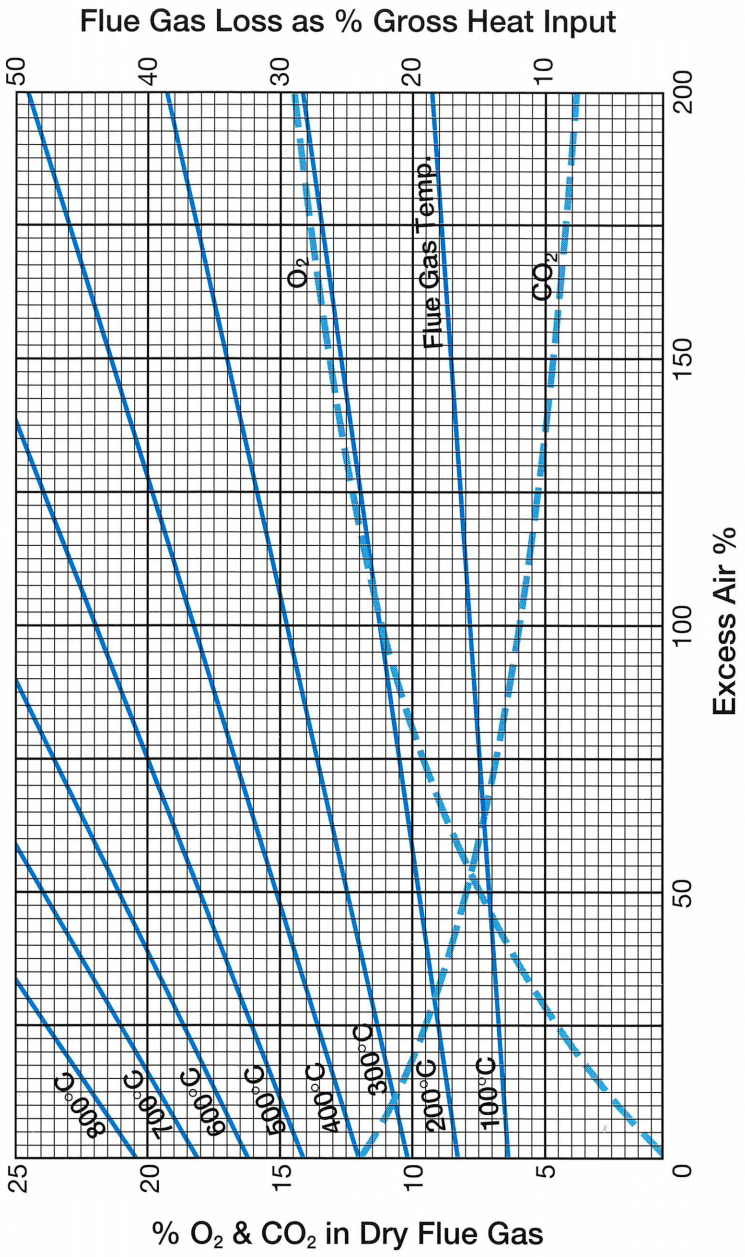


FIGURE 2 Percentage Heat Losses at Various Flue Gas Temperatures and Percentages of Excess Air for NATURAL GAS (source: Natural Gas Data, Gas and Fuel Corporation of Victoria, 1986)



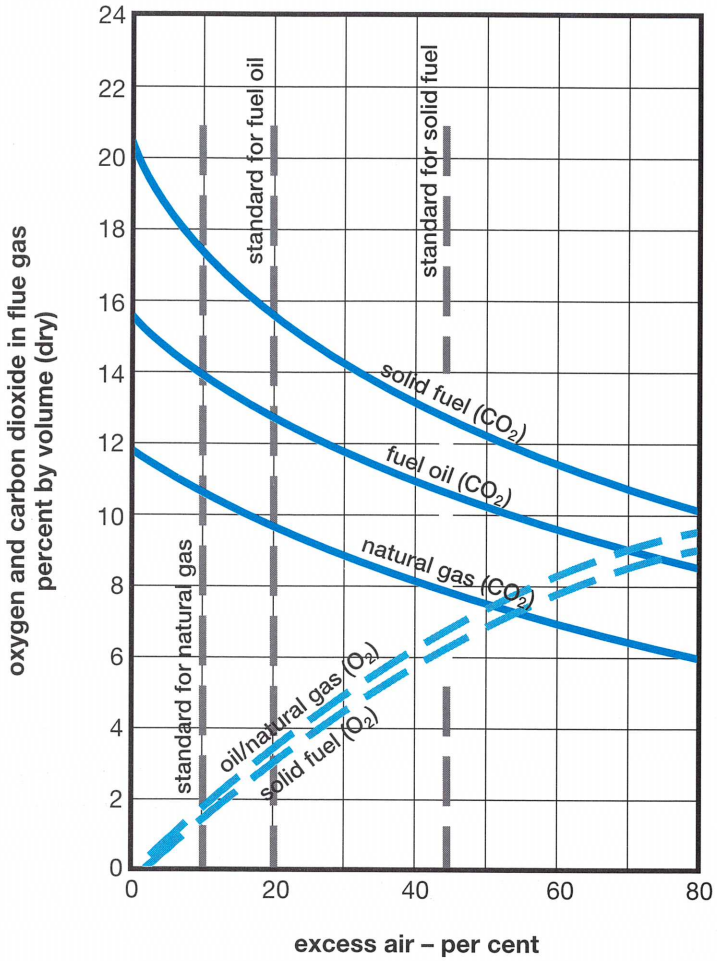
Environmental Issues

The combustion of any fuel has an impact on the environment and all fuel burning equipment has to be installed and operated in accordance with the requirements of Environmental Protection Agencies (EPA). The requirements for gas and liquid fuels are mainly aimed at ensuring that the combustion process is under control at all being carried over from the combustion chamber with the flue gases. To minimise the risk of solids fall-out it is standard practice for the EPA to nominate a maximum particulate level in the flue gases. Compliance usually requires the fitting of a grit arrester and bag filter to treat the flue gases.

An environmental issue of increasing concern is that of 'greenhouse gases'. The gas of greatest concern is CO_2 which is produced in the burning of all fuels. The suggested solution to the problem is to reduce CO_2 emissions to a level that existed in previous years. However, this could present major difficulties to Australia with its dependence on coal-fired power generation, and mineral and agricultural production – all activities associated with CO_2 emissions. The preferred approach is for industry to voluntarily reduce emissions. A reduction in emissions can be achieved by reducing fuel use by being more efficient, or switching to a fuel which produces less CO_2 per unit of energy produced, such as natural gas.

The demand for steam, and hence the use of fuel, in the meat processing industry is mainly for the provision of heat for the rendering process, the generation of hot water, and temperature maintenance in water and tallow storage systems. A significant portion of the steam demand can be met by the recovery of heat from other processes,

FIGURE 3 Guide to Optimum O_2 and CO_2 Levels in Flue Gases from Steam Boilers (source: Thomas Borthwick and Sons)



in the cost of services. In an industry where cost pressures are ever present the latter advantages would be of direct benefit.

The weights of CO_2 produced (gram per MJ of energy) from a range of fuels are as follows:

black coal	90.0g/MJ
brown coal	95.0
natural gas	51.3
heavy fuel oil	73.3
light distillate	69.7
wood	94.0
automotive gasoline	66.0

Source: ABARE Research Report 97.2

Additional Information

'Energy Conservation Case Studies', New Zealand Energy Research and Development Committee, August 1981, p. 51.

'Energy Management for the Meat Industry', CSIRO Meat Research Laboratory Seminar Papers, 1983.

'Cost-effective Energy Use in Meat Processing', Energy Authority of NSW, 1985.

'Condensate and Flash Steam Recovery', 1990, Spirax Sarco Ltd. Technical Reference Guide, p. 38.

Additional information

Additional help and advice are available from Food Science Australia, Meat Industry Services Section:

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