Combustion in Wood-Burning Stoves

PLATINUM CATALYST INCREASES THERMAL EFFICIENCY AND GREATLY REDUCES POLLUTION

The use of wood as a residential heating fuel has always been popular in the Scandinavian countries. More recently there has been a significant increase in the use of wood-burning stoves in many other parts of the world, especially in the United States of America. This trend was initiated by the escalating costs of fossil fuels and electricity and, to a certain extent, public concern about the reliability of future supplies of these fuels.

Heating with wood fuel can be less costly than heating with coal, oil or electricity, especially in rural and some suburban areas where wood is relatively inexpensive and plentiful. Furthermore, modern wood-burning stoves are at least as efficient as oil and gas fires. Tests have shown that radiant, damped-draught wood-burning stoves deliver from 50 to 70 per cent of the energy available in the wood to the surrounding living area.

Despite all its advantages the wood-burning stove does present some problems, not the least of which is smoke.

The main difficulty is that there is no economical method of continuously feeding a measured amount of wood into the stove to control the heat output. Large amounts of fuel are loaded into the stove and the combustion rate is controlled by the amount of air available. The unburned wood is heated to the point at which combustible volatile components are distilled off. These components comprise hydrocarbons (including polycyclic aromatic hydrocarbons), aldehydes, phenols and carbon monoxide and are often incompletely burned in the stove because there is insufficient air available for combustion. Even when sufficient air is available, temperatures are often too low to bring about any significant degree of burning. The nett result is that these volatile components can be released from the stove to either condense in the chimney or be emitted to the atmosphere. The condensed materials contribute to the danger of chimney fires while the smoke emissions can cause significant air pollution. Furthermore, the overall effect is a significant loss of potential heating value.

The application of new technology in the design of wood-burning stoves can now largely overcome the basic problems associated with their operation. The requirement is for a method of operation which enables smoke to be

Fig. 1 The platinum metal catalyst is located in the secondary combustion chamber of the stove. The three-tier design provides a large surface area and hence efficient heat exchange

burned at the temperatures existing in a stove operating under damped conditions. These temperatures are typically in the range 200 to 400°C. The use of platinum group metal catalysts supported on ceramic honeycomb substrates is now a well established method of controlling emissions of unburned hydrocarbons and carbon monoxide from motor vehicle exhausts. The catalyst reduces the combustion temperature of the hydrocarbons and carbon monoxide so that they start oxidising at temperatures around 250°C. The catalytic reaction increases until the system reaches an equilibrium between the inlet gas temperature, the gas-flow rate and the amount of combustible material in the gas stream. The equilibrium temperature can be as high as about 800°C for an optimum sized catalyst system and at this temperature essentially complete oxidation of the combustibles in the gas stream proceeds very rapidly.

During the course of the past few years the application of catalytic oxidation to promote secondary combustion has led to the appearance on the market of a new generation of wood-burning stoves. One such product has recently been launched by Trolla Brug, a long established Norwegian company. Appropriately named the Pioneer, it combines the traditional appeal of a cast iron stove with the modern technology of catalytic secondary combustion.

The stove is a three-tier design comprising a primary combustion chamber, a secondary combustion chamber incorporating the catalyst and a third storey which acts solely as a heat exchanger. The catalyst, which was specifically developed by Johnson Matthey Chemicals Limited for wood-burning stove applications comprises platinum metal dispersed on a low cell density ceramic honeycomb support. The multi-storey design provides a large surface area for maximum heat exchange efficiency. The incorporation of the catalytic afterburner is claimed to result in a 30 per cent reduction in wood consumption for the same useful heat output compared to the non-catalytic version of the same stove. In addition smoke emission levels are greatly reduced and the potentially dangerous accumulation of inflammable condensates in the chimney avoided. A.E.R.B.

Osmium Doping Improves Recording Media

THIN FILMS HAVE HIGH COERCIVITY AND COERCIVE SQUARENESS

In magnetic recording the continuing demand for ever increasing recording density has stimulated research on thin films of continuous magnetic materials suitable for the production of high capacity storage discs. Sputtered γ-Fe_2O_3 thin films are attractive for this application in view of their high coercivity and high remanent magnetisation, combined with their resistance to corrosion and wear, and a γ-Fe_2O_3 film containing small amounts of cobalt, copper and titanium has been developed. The function of these additions is to increase the coercivity of the film, to improve coercive squareness, to widen and lower the temperature range of the α-Fe_2O_3 to Fe_3O_4 reduction—so making it possible to obtain uniform magnetic properties—and also to suppress grain growth during heat-treatment.

Now workers at the Ibaraki Electrical Communication Laboratory in Japan report that remarkable improvements have been made to the magnetic properties and microstructure of sputtered γ-Fe_2O_3 thin films when osmium is used as an additive element (O. Ishii and I. Hatakeyama, *J. Appl. Phys.*, 1984, **55**, (6), 2269–2271).

Films 0.1 to 0.2μm thick have been prepared by reactive magnetron sputtering, the target being an iron plate to which osmium pellets were attached. Coercivity and coercive squareness increased with osmium content, to maximum values of 2100 Oe and 0.81, respectively. Osmium doping also brought about field-induced anisotropy which greatly increased the coercive squareness parallel to the easy axis, a figure of 0.96 being obtained with 0.88 to 5.2 atomic per cent osmium. Osmium also suppressed grain growth during preparation, giving crystallites about 400 Å in diameter which improves the signal to noise ratio, an advantage for increasing recording density and read back amplitude.