STEADY STATE TUBE FURNACE (PURSER FURNACE) (BS 7990, IEC 60695-7-50 AND ISO 19700)

WITH FTIR (NEXUS FTIR WITH 4 M PATH LENGTH GAS CELL AND HIGH SENSITIVITY MCT DETECTORS.

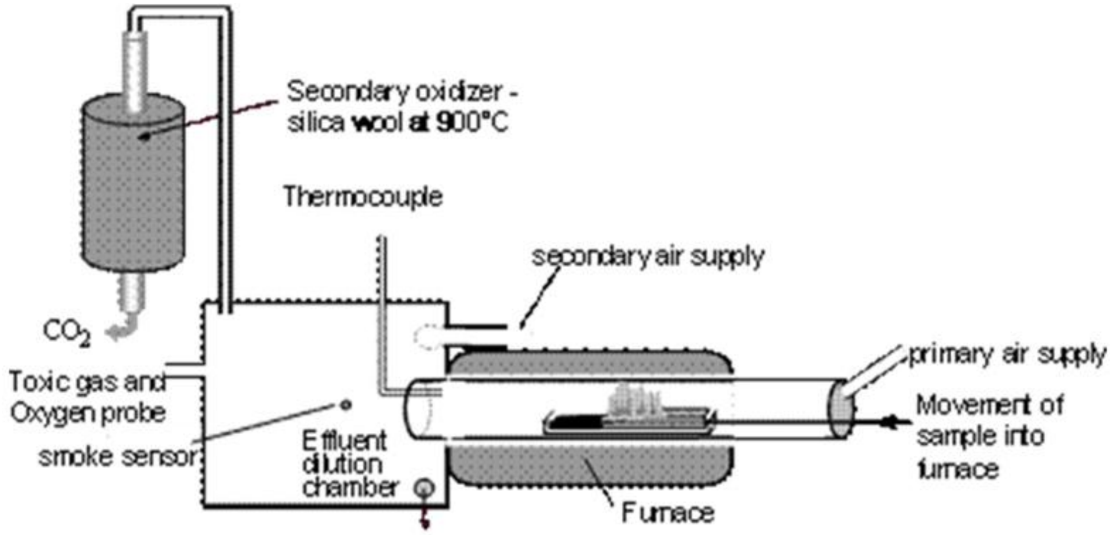
Although true steady state conditions rarely exist in real fires, the ability to generate real fire conditions in a steady state is important as it enables complex chemical reactions to be studied in more detail than in a rapidly changing situation. It is important to simulate the different fire conditions as these can have a significant effect on the effluent produced. The Purser furnace is designed as a physical fire model primarily for the assessment of fire effluents including gas toxicity, smoke density and particulates. The toxicity of fire gases is of increasing importance, particularly now that performance based codes require an assessment of the toxic hazard from fires.

Most fire deaths arise from toxic gas inhalation (particularly carbon monoxide (CO) and hydrogen cyanide (HCN), and almost all small-scale tests underestimate the yields of CO and HCN by factors between 10 and 100. This arises because it is difficult to sustain burning on the small scale in the oxygen depleted atmospheres that occur in real fires.

The assessment of fire retardant behaviour now has the added dimension of burning behaviour under conditions found in a developed fire. For these studies, only the Purser furnace (for steady state burning) or Factory Mutual's Fire Propagation Apparatus (for rate of fire growth) are capable of sustaining combustion under the oxygen depleted conditions of a developed fire.

The apparatus consists of a tube furnace with a moving test specimen, controlled temperature and air flow. The apparatus has been used very successfully as a research tool, establishing a correlation between CO yields (the most toxic component in most fire gases) and the equivalence ratio (actual to stoichiometric fuel/air ratio). These data show excellent correlation to large scale tests.

This complements the techniques currently in use at UCLan for understanding the chemistry of materials in fire. It has been designed by reference to real fires, and the test conditions are chosen to represent different stages and types of fire for studies of smoke and toxic combustion product evolution from polymers. The creation of exact and meaningful conditions is essential if meaningful data are to be obtained when studying fire with laboratory experiments, since smoke and toxic gas generation is markedly dependent upon temperature and oxygen concentration.



In particular the Purser furnace has been designed to reproduce the different stages and types of fire:

- smouldering/non-flaming;
- small , early, well-ventilated flaming;
- large, fully developed/post flashover, vitiated;
- fully developed, well-ventilated.

The technique allows for steady combustion conditions to be established. In addition to continuous monitoring of the key components of the fire gas, other volatile species may be analysed from grab-sampling by GC-MS and other techniques.

The present set up uses a combination of non-dispersive infrared (CO2 and CO), paramagnetic analyser (furnace tube O2) and electrochemical cells (CO, secondary O2). Other non-continuous analytical techniques (such as wet chemical analysis or GC-MS) can be used as required.

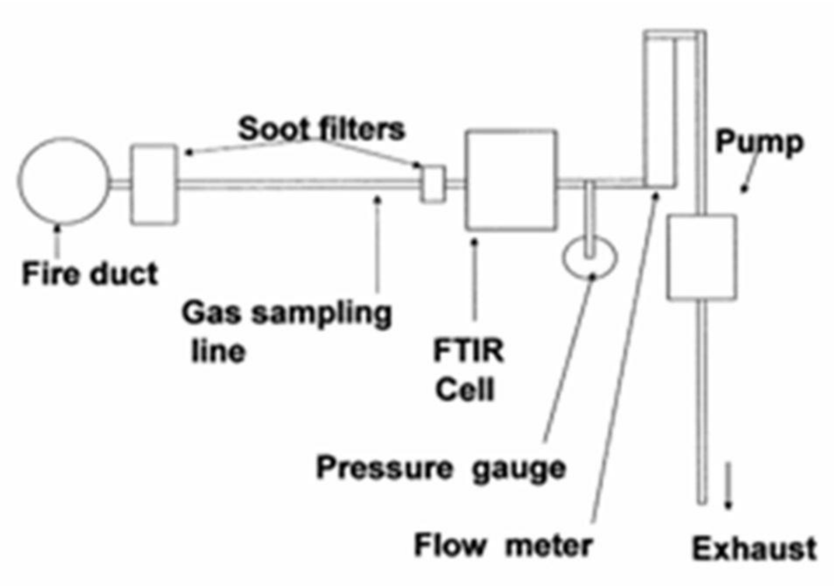
Time based gas concentration data for a wider range of species may be determined using Fourier Transform Infrared Spectroscopy (FTIR).

FOURIER TRANSFORM INFRA RED (FTIR) ANALYSIS OF FIRE GASES

In this technique, a beam of infra-red with wave numbers from 400 to 4000 is passed through a sample of fire gas in a heated cell. The various structural groups of the fire gases molecules will absorb different amounts of energy in different parts of the infra-red spectrum. The components of the gas mixture can be identified by the overall shape of the intensity of the absorption at different wave numbers while their concentration of the gases can be determined by the intensity of the absorption. This technique can identify and quantify most of the important fire gases in a single operation. The infra-red absorption spectra can be recorded and re-analysed at a future date for gases not included in the original analysis. The technique can be applied to a gas flow which enables gas concentration / time curves to be obtained.

FTIR only measures the infra-red absorption data over a range of wave numbers. There is no unique absorption band for every gas and absorption spectrum consists of the summation of all the over lapping and interfering absorptions. The analysis of the fire gas spectrum for specific gases needs to consider interferences from the other gases present and requires the use of complex mathematical models, experience and common sense as well as multiple gas calibrations at different concentrations. The absorption of minor amounts of gas onto the filters, sampling lines, etc. and the necessity to remove soot from the gas stream results in some errors. However FTIR is a very powerful tool for fire gas analysis and complements the other techniques such as GCMS.

SCHEMATIC DIAGRAM OF FTIR GAS ANALYSIS EQUIPMENT



THE SIMPLE FTIR ABSORPTION SPECTRUM OF BURNING METHANE