Transcript of Smoking Machines video

In order to undertake chemical and biological research on cigarette smoke, it is important to develop and use analytical techniques to generate and collect smoke in a standardised and reproducible manner, so that the data from one laboratory can be compared with the data from another.

A key tool is the smoking machine that smokes cigarettes in a prescribed manner. There are two kinds of smoking machine, linear and rotary. Both kinds typically have 20 ports, where, for reasons of analytical throughput and minimising variability 20 cigarettes are smoked at the same time.

With linear machines, several different cigarettes, including reference cigarettes, can be smoked in the same run with typically five cigarettes smoked onto each Cambridge filter pad.

In contrast a rotary machine will smoke up to 20 of the same type of cigarette onto one pad; which is particularly suited to the analysis of constituents which are present at very low levels in cigarette smoke.

Environmental factors can affect the amount of smoke collected, so the laboratory conditions have to be tightly controlled in terms of temperature and humidity; constant ambient temperature and humidity conditions are used for the smoking process and for pre-conditioning the cigarettes and the filter pads used to collect the tar.

In order to measure tar a Cambridge filter pad is placed into an inert holder and weighed. The cigarettes are pre-marked at a measured distance from the filter end to ensure that they are smoked to a consistent position.

With linear smoking engines the holders are placed at each port on the machine and cigarettes inserted into the holders. Cotton is wound around switches which stop the puff when the cotton is broken.

Rotary machines can employ automated systems to ensure smoking ends at the appropriate time.

Air flow within smoking machines is kept at a pre-determined level. When smoking according to the standard ISO smoking methodology, the machine takes a thirty five millilitre puff over a period of two seconds once every minute until the cigarette burns down to the butt mark, when puffing is stopped by the machine.

The holder is then removed and the filter pad and holder re-weighed to get the weight of total particulate matter collected. By convention, tar is the total particulate matter minus the amount of nicotine and water, and so the next step in the procedure is to extract the pad in order to analyse for nicotine and water. Extraction of the pad with various solvents leads to extracts that can be used to measure other

analytes, such as tobacco-specific nitrosamines, or that can be used in toxicological experiments.

Cigarette smoke contains particles, vapours and gases.

Chemicals in the gas phase of smoke may pass through a Cambridge filter pad, and so additional collection devices or "traps" are needed for their analysis.

When analysing vapours, and some other low level constituents, Cambridge filter pads are not used and the whole smoke is passed through traps. The traps vary somewhat depending on the analyte. For carbonyl compounds such as formaldehyde liquid traps are used that rely upon a solution of two, four-dinitrophenylhydrazine.

In order to ensure effective collection of the vapours, two traps are placed back to back. Each puff of the cigarettes is then drawn first through an empty filter holder and then through the traps.

For gases such as carbon monoxide the collection is in inert bags, which are then analysed using an infra-red device.

A range of analytical techniques is used to quantify individual constituents of smoke from the materials generated by the smoking machine. For example tobacco specific nitrosamines would be measured using liquid chromatography coupled with mass spectrometry.

Smoking machines are run under standardised conditions and therefore do not mimic the range of smoking behaviours seen amongst smokers. Data from smoking machines is only a first step in evaluating whether a novel product has, when measured under laboratory standardised conditions, lower levels of toxicants than a conventional cigarette.