Work practice measurements- The PIMEX method

Gunnar Rosén and Ing-Marie Andersson
grs@du.se ima@du.se

Högskolan Dalarna
S-781 88 Borlänge
Sweden

Introduction

In practical occupational health work, direct-reading instruments of various types are important aids in monitoring concentrations of air contaminants in workplaces. Rapid measuring instruments, sometimes small and battery-operated, make it possible to collect large amounts of data at different times and monitoring points. One problem that soon arises is how to relate this mass of data to factors at the workplace that can explain changes in the concentration of the contaminant being monitored. One common method is to transfer the information from the monitoring instrument to a printer or into some type of data logger, and in a subsequent operation correlate each concentration with an exact point in time. The accuracy of the following analysis is then completely dependent on the detail and accuracy of the notes on what was going on in the workplace at that time. Practical experience has shown that with this method it is not possible to capture more than a small fraction of the occurrences that affect the readings.

This was the state of affairs in 1984, when the authors began to explore the possibility of developing a more efficient way to store information about relevant occurrences at the workplace by using video filming as a complement to the direct-reading instruments. A year later this development work had resulted in a system which was soon dubbed PIMEX(Rosén and Lundström 1987, Rosén and Andersson 1989, Rosén 1993). The name PIMEX is an acronym from the words PIcture Mix EXposure, and implies that the method is based on mixing pictures, in this case from a video camera, with data on a worker's exposure to some agent..

Different technical solutions for PIMEX has been developed by different research groups and companies. Two systems are for the moment available on the market. More information can be seen on: www.pimex.at or www.teaergo.com/

Other systems, such as FINN-PIMEX from VTT in Finland and Exposure Video Visualisation (PIMEX) from HSL in England are not made available on the market. They are developed and used for internal research needs and to offer occupational health service.

PIMEX-PC, developed at the National Institute for Working Life in Sweden is described in this text.

PIMEX-PC

PIMEX-PC is based on the use of a standard PC and special software.

It has the following basic components:

- A direct-reading monitoring instrument, usually for air contaminants, which is placed in a small backpack to be worn by the studied worker (as in other systems).
- A video camera.
- A computer (Lap Top preferable).
- Software

The monitoring instrument is attached to a short tube in such a way that samples can be taken in the worker's breathing zone. For practical reasons, it is usually placed on the shoulder. Either a cable or a transmitter for wireless transmission of the signal (telemetry) is connected to the instrument's output to a recorder.

The video camera is usually placed on a tripod and aimed at the worker while the measurements are being made. If a wide-angle lens is used, it is usually not necessary to move the camera unless the worker moves around quite a bit. In these cases a camera man is needed to keep the camera aimed at the worker.

One example on how the picture and data are presented in PIMEX-PC is shown in fig.1

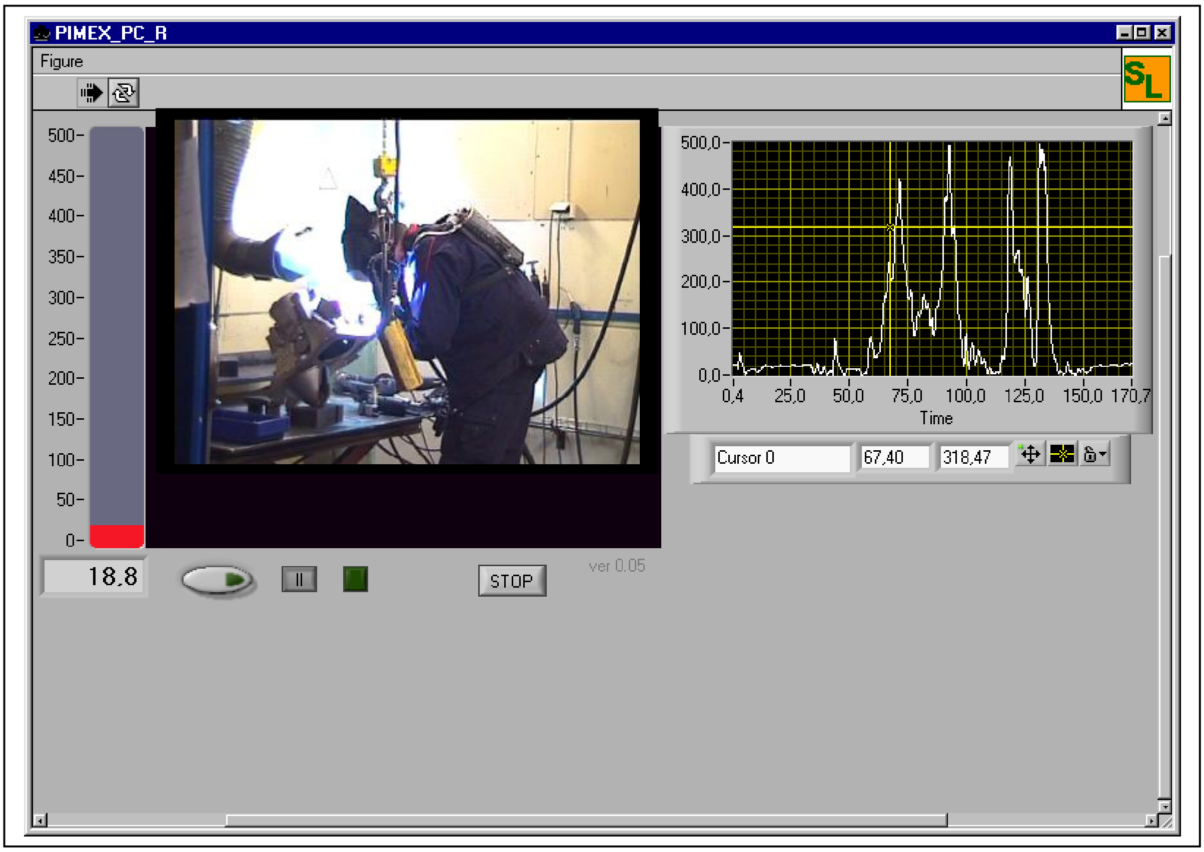

Figure 1. This illustration shows an example from a PIMEX-PC recording. The video picture window shows a person welding. The welder is carrying a real time monitoring instrument for dust and smoke in his back pack. The instrument samples in the breathing zone of the worker. The signal from the instrument is transferred by telemetry to the used PIMEX-PC computer.
The graph window to the right of the video window shows how the welders exposure to welding smoke has varied during the total sampling time 318.47 s. Time on X-axis and exposure level on Y-axis.
A vertical, yellow marks where in the video/sampling sequence we are for the moment. This example from the recording is from 67.40 s after start. The red bar to the left of the video picture and the digits below the bar shows the exposure level for the moment.
It is also possible to display special information about when and where the recording has been made.
It is easy to scroll through the recording by dragging the vertical line in the graph to any point of interest, e.g. to view what caused a certain peak in the exposure.

The monitoring instruments used with the PIMEX method must have a short response time, preferably no longer than a second or two. The reason for this is that it has to be possible to relate a change in the monitoring values to the occurrence that caused the change. The response times typical for instruments based on semiconductors or electrochemical cells are therefore too long. If the monitoring value rises as a result of something that was shown on the video screen a minute and a half ago, the only result is confusion. The monitoring instrument has to be relatively small and lightweight, and preferably battery-operated, so that it can be carried in the backpack. One type of instrument that meets these requirements is the battery-powered photoionization instruments that can be used for most volatile organic compounds (VOC) and also for a number of inorganic gases. Another is light scattering instruments for aerosols. Both these types of instruments also have detection limits that are usually quite adequate for practical monitoring at workplaces. Together they can be used to (non-specifically) monitor more than half of the substances on the Swedish list of occupational exposure limits. The fact that these instruments do not make specific measurements is seldom much of a problem in practical work. Several other types of instruments can also be used, of course, though there are some limits. If the instrument is large or heavy or has to be plugged into a power outlet, it may be possible to use a longer hose from the worker's breathing zone to the instrument.

Telemetry for wireless transmission of the monitoring signal from the instrument to the video mixer is extremely helpful, since it allows the worker to move around relatively unencumbered by the monitoring device. Experience has shown, however, that in many cases it also works quite well to transfer the signal via a cable, especially if the studied worker is sitting at a work station or moves around very little: welding, spray painting in a booth, and laboratory work at a fume cupboard are a few examples.

The PIMEX-PC equipment can be handled by one properly trained person. We have found, however, that it’s usually much better to be two persons, especially if the worker moves around so that the camera can not be on a stationary mount, if telemetry is not used and a cable has to be attached to the worker, etc. Furthermore, PIMEX studies made at workplaces usually arouse so much curiosity among other workers in the vicinity that one person is kept busy providing a running commentary on what is going on. This kind of communication has a further value, since suggestions for improvement often arise in the group that stands around watching the video.

Uses

The uses of the PIMEX method can be roughly divided into three categories:

- Direct intervention at workplaces
- Production of training films
- Research

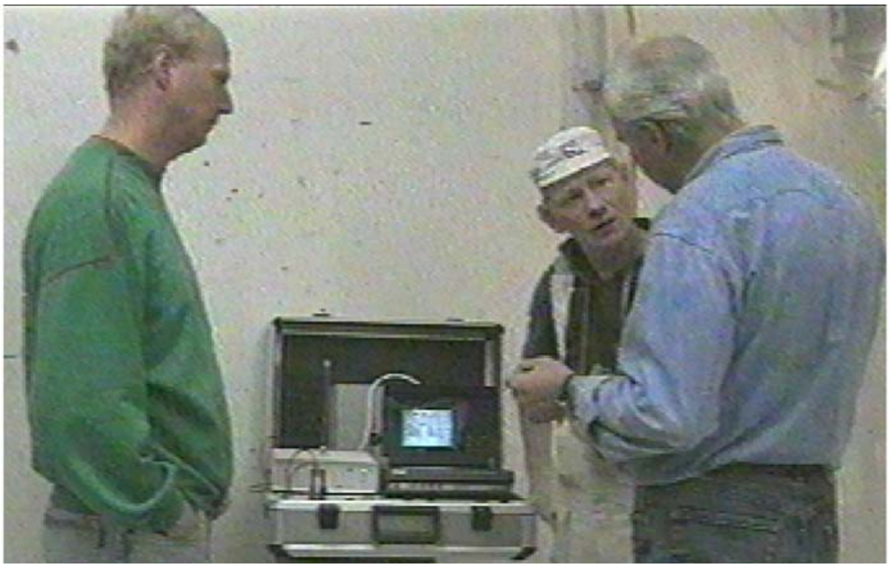

Figure 2. By watching the video, the personnel involved develop a better understanding of the connection between the situation at the workplace and the exposure that arises.

For direct intervention, PIMEX has three important advantages. By watching recorded material, the personnel involved develop a better understanding of the connection between the situation at the workplace and the exposure that arises (Fig. 2). This knowledge is considerably more difficult to communicate when the monitoring results are presented in reports, tables or figures. Presentation is made even easier by the fact that the results can be viewed as the measurements are being made.

A second positive effect is that workers usually become more aware of occupational exposures. Seeing yourself on video along with information on how your exposure varies with working method etc. is usually quite a kick in the right direction.

Third, and perhaps most important, is the information that the ventilation expert, occupational hygienist etc. can get. The material makes it possible to study in detail the effects of various improvements introduced at the workplace --isolation of machines, ventilation modifications, new working methods etc. These three effects provide a very important basis for remedial measures.

A workplace improvement strategy by PIMEX (WISP) has been developed by a research team from Austria, Finland and Sweden.

Production of training films is an area of use that makes it possible to spread the knowledge gained at one workplace to a larger circle. The results of a successful (or unsuccessful) measure can be worth knowing about at other workplaces with the same or similar problems.

A film made like this will not have the picture and sound quality of a professionally made one, but this is often offset by the quality of the message. Of course, if the training film is to be produced for wider distribution, an investment in professional quality picture, sound and direction may be worthwhile.

As a tool for research, PIMEX provides many opportunities. The wealth of information that is found in a picture, combined with the monitoring data from one, two or possibly more instruments, can provide the basis for research on such topics as the connection between production parameters and exposure. The technique has also been used to assess the effects of various ventilation systems (Andersson et al. 1991, 1991 and 1993).

PIMEX has numerous areas of application. A few of them are listed below. The list covers more than air contaminants: the method has no such limits. Any instrument that provides a signal that can be processed by the video mixer can be connected to the equipment.

Painting of furniture, organic solvents
Wood dust in the furniture industry
Screen printing organic solvents
Paint manufacturing, organic solvents
Nitrous oxide exposure during surgery
Smoking of sausage carbon monoxide
Production of flag poles, styrene
Production of man made mineral fibres, dust and smoke
Welding fumes
Dust in ceramic production
Styrene exposure in a boat-factory
Electromagnetic field exposure
Organic solvent , degreasing
Gasoline exposure, car service
Dust in a pharmaceutical factory
Dust exposure, chimney sweeping
Solvent exposure in a laboratory
Ammonia on a farm
Soldering fumes
Laboratory studies of a ventilation system
Vibrations in a bus passing speed bumps
Solvent exposure, degreasing in an airplane factory
Wood dust in a furniture factory 1992
Quarry dust
Organic solvents, dust and work load (EMG),in a foundry
Organic solvents, dust and work load (EMG) in a paint factory
Organic solvents, dust and work load (EMG) in a rubber industry

Related techniques

With PIMEX-PC are all data stored on the computer for further analysis. Calculating average values over specified time intervals and production of various graphic presentations are a couple of examples.

Detailed exposure analysis is a method that has been developed from the PIMEX method (Andersson and Rosén 1995). With access to the results of exposure monitoring in a computer file, combined with the video film, it is possible to separate the exposures for different tasks. This job is easily done (but it takes time) by noting the start and stop time for each task. The monitoring data can then be sorted according to task. Detailed information on the contribution made to total exposure by each task can be calculated by this kind of analysis, for example. Figure 3 shows a result from one such analysis.

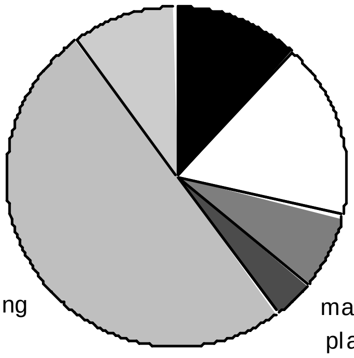

Figure 3. Results from a detailed exposure analysis. The example shows a carpenter’s exposure to wood dust during a certain work day. The different sectors of the pie chart illustrate the relative contribution from each work task to the total exposure dose.

References

Andersson I, Niemelä R, Rosén G, Säämänen A. Control of Styrene Exposure by Horizontal Displacement Ventilation. Appl Occup Environ Hyg 8(12) (1993).

Andersson I, Rosén G. Detailed work analysis for control of exposure to airborne contaminants in the workplace. Appl Occup Environ Hyg 10(6), (1995) 537-544.

Andersson I-M, Niemelä R, Rosén G, Welling I, Säämänen A. Evaluation of a local ventilation unit for controlling styrene exposure. Ventilation 91. Proceedings of 3rd International Symposium on Ventilation for Contaminant Controll, Cincinnati, 16-20 September (1991) 161-166. ACGIH.

Andersson I-M, Rosén G, Kristensson J. Evaluation of a ceiling-mounted low-impulse air inlet unit for local control of air pollution. Ventilation 91. Proceedings of 3rd International Symposium on Ventilation for Contaminant Controll, Cincinnati, 16-20 September (1991) 209-213. ACGIH.

Rosén G, Andersson I-M. Video filming and pollution measurement as a teaching aid in reducing exposure to airborne pollutants. Ann Occ Hyg 1 (1989) 137-144.

Rosén G, Lundström S. Concurrent Video Filming and Measuring for Visualization of Exposure. Amer Industr Hyg Ass J 48 (8) (1987) 688-692.

Rosén G. PIMEX. Combined use of air sampling instruments and video filming: Experience and results during six years of use. Appl Occup Environ Hyg 8(4) (1993).