Diesel engines

The use of diesel engines is increasing steadily. What are the pros and cons?

The diesel engine is robust, has a long working life, and is fuel efficient. It has been used widely in ships, railway locomotives, and as a stationary engine to provide power, and there is increasing use worldwide in heavy duty and public transport vehicles and passenger cars. Diesel-engined vehicles are widely used in underground mines and it is here that there is the highest human exposure.

Major advances in diesel engine design have been made in recent years. The diesel engine is an efficient energy converter and can reach thermal efficiencies approaching 50%, resulting in low energy consumption and low emissions in terms of distance travelled. Thus, it is considered more “environmentally friendly” than the petrol engine.

The principal emissions are carbon dioxide, carbon monoxide, nitrogen oxides, hydrocarbons (including polycyclic aromatic hydrocarbons), sulfur oxides (depending on the sulfur content of the fuel), and particulate matter. It is simpler to produce diesel fuel than petrol from crude oil, and “green” alternatives such as methylated vegetable oils are available and used.

Many countries are considering their strategies for motor vehicle propulsion into the next century, and increased use of diesel engines may be one of the outcomes until effective substitutes for the internal combustion engine are widely available. However, there is concern about the possible human health implications of diesel exhaust emissions. Components of particular concern are

White spirit

There cannot be many people, at least in industrialized countries, who have not at some time in their lives encountered white spirit, or Stoddard solvent as it is more commonly known in N. America. It is a common component of the solvent in a wide variety of paints, and is used by both amateurs and professional painters as a paint thinner and for cleaning paint brushes.

Owing to its excellent solvent properties, it is also used in wood preservatives, lacquers, varnishes and as a cleaning and degreasing solvent.

In order to assess the health risks of white spirit, an IPCS Task Group meeting was held in November 1995. The results of the deliberations of this group of experts will be

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**Diesel engines**

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polycyclic aromatic hydrocarbons, many of which are known carcinogens, and particles (which are, in fact, agglomerates of carbon).

**Evaluations**

Diesel exhaust emissions were evaluated in 1988¹ by the WHO International Agency for Research on Cancer and classified as Group 2A (probably carcinogenic to humans), based on sufficient evidence for carcinogenicity in experimental animals of diesel exhaust and extracts and limited evidence for carcinogenicity in humans.

An IPCS Task Group² evaluated diesel fuel and exhaust emissions in 1993. For emissions a number of end-points were assessed including dosimetric extrapolation from rat carcinogenicity studies. Long-term inhalation studies of diesel exhaust in rats at particulate concentrations greater than 2 mg/m³ resulted in lung cancer. However, chronic inhalation by rats of similar concentrations of carbon particles or high concentrations of titanium dioxide or talc gave the same results. Inhaled diesel exhaust was not carcinogenic in hamster studies and results in mice were negative or equivocal.

This has led to a hypothesis that particle-induced lung cancer is due to “particle overload” and the possibility that a non-genotoxic mechanism might be involved. As rats appear to be more susceptible to inflammatory, fibrogenic and carcinogenic effects of inhaled particles than guinea-pigs, mice or humans, direct extrapolation of carcinogenic risk from rats to humans needs careful consideration.

Non-cancer end-points were also evaluated including impairment of alveolar macrophage-mediated clearance function, chronic alveolar inflammation and lung epithelial hyperplasia. Data on these end-points from rat studies were used to derive no-adverse-effect levels and benchmark concentrations of particulate diesel exhaust for these significant non-carcinogenic effects.

**Epidemiology**

In the case of the human epidemiology there was considered to be some evidence for an excess risk of lung cancer varying with the occupation, but an association between diesel exhaust exposure and bladder cancer was not established. The occupational epidemiological studies were on diesel locomotive drivers and maintenance personnel, diesel bus garage staff, mine workers, truck drivers and crews of “roll-on, roll-off” ferries. These were retrospective, made assumptions on exposure, and generally had difficulty in correcting for tobacco smoking. The Task Group agreed that they could not be used for a quantitative risk assessment.

Another review of the potential of diesel exhaust emissions to cause adverse health effects was published in 1995 by the US Health Effects Institute³. This concluded that diesel exhaust emissions were carcinogenic in rats but not in other species tested. Thus, species-specific factors, notably impaired lung clearance of particles and associated chronic alveolar inflammation, could play a critical role in the induction of lung tumours. Caution in the use of rat data to make quantitative risk assessments for humans was recommended. The review concluded that epidemiological data were consistent in showing a weak association between lung cancer and long-term exposure to diesel exhaust, even when confounding by tobacco smoke was controlled for. However, the lack of reliable exposure data limited the interpretation of the epidemiological data and their use in quantitative risk assessment.

**Engineering improvements**

Bearing in mind the potential health effects of diesel exhaust, engineering improvements to diesel engines are greatly improving emission quality. Particle traps have been developed for diesel engines, and catalytic converters will deal with hydrocarbons, carbon monoxide and nitrogen oxides. The formation of sulfur oxides is prevented by desulfurizing the fuel during production. The removal of particles from diesel exhaust would remove a possible major source of adverse health effects. A key factor influencing the speed of change to “cleaner” diesel engines will be national attitudes to possible health effects and associated protective legislation.


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**Poisoning by pesticides in China**

The situation regarding poisoning by pesticides during 1994 and 1995 has been examined in meetings organized by the Emergency Medicine Branch of the Chinese Society of Medicine. At the March 1994 meeting, organophosphates were reported to have been responsible for 6616 cases of poisoning, pyrethroids for 188 cases, formamidines for 113 cases, carbamates for 91 cases, mixtures of pesticides for 118 cases and various unclassified pesticides for 243 cases.

The meeting also addressed the causes of sudden death during recovery from severe organophosphate poisoning and the use of diazepam or a mixture of atropine and oxime in the treatment of organophosphate poisoning.

The meeting held in September 1995 reported 18,287 cases (528 deaths) of poisoning due to organophosphates, 530 cases (13 deaths) due to formamidines, 157 cases (2 deaths) due to pyrethroids, 106 cases (no deaths) due to carbamates, 489 cases (13 deaths) due to rodenticides and 9 cases (no deaths) due to herbicides.
White Spirit

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published next month as Environmental Health Criteria 187: White Spirit.

White spirit is a complex mixture of hydrocarbons derived from the fractional distillations of petroleum. It has a characteristic odour and the vapour can be detected at low concentrations in the air. Consequently, people who use white spirit or even those exposed to it through sleeping in a recently painted bedroom may question whether it is doing them any harm.

It is advisable to treat white spirit with a healthy respect. Firstly, it is a flammable liquid, presenting a moderate fire and explosion risk. Secondly, prolonged exposure of the skin, for instance through wearing clothes that have been soaked by white spirit, can lead to severe irritant dermatitis due to defatting. Slight irritation of the eye, nose and throat can occur at a vapour concentration of 100 ppm.

If white spirit is accidentally swallowed, droplets can enter the lungs. It only requires a small amount to produce serious bronchopneumonia. However, the most common means of exposure to white spirit is through inhaling the vapour. All-day exposure to 100 ppm has been found to result in fatigue, dizziness and impaired balance. Exposure to very high concentrations in enclosed spaces can lead to narcotic effects and loss of consciousness.

Numerous epidemiological studies have been performed involving painters with long-term exposure to white spirit. Indeed the range of symptoms commonly shown by this occupational group has given rise to the term “painters’ syndrome”. Increased incidence of complaints of concentration and memory impairment, irritability, headache, anxiety and apathy have been demonstrated in several cross-sectional studies. Studies including neuropsychological tests have shown impaired ability in performing some of the tests. The frequent occurrence of these signs among workers in house painting implicates white spirit in the development of “chronic toxic encephalopathy”. In some countries this is recognized as an industrial illness. In severe cases the adverse effects have resulted in the award of a disability pension.

In studies of dry cleaners, where white spirit was the predominant cleaning solvent, increased risks of respiratory, pancreatic and kidney cancer were reported. There is also evidence of increased risks of cancer, particularly in the lung and bladder, among painters.

There is general agreement that brush and roller application of alkyd paints leads to an average white spirit concentration in air of around 100 ppm. Since painters spend around 40% of their time applying alkyd paints (as opposed to applying water-based paints or preparing surfaces), the average daily 8-h exposure has been estimated to be 40 ppm. Without ventilation, exposures can peak at much higher levels (300-1000 ppm). Models relating exposure to the effect of white spirit on house painters suggest that exposure to an average concentration of 40 ppm for more than 13 years could lead to chronic central nervous system effects.

Recommendations from the IPCS Task Group on White Spirit

1. In order to reduce exposure concentrations for the general public and the occupationally exposed, paints based on white spirit should not be used in inadequately ventilated areas.
2. All practicable methods should be used to minimize exposure of indoor painters to white spirit. Greater use should be made of water-based and other paints.

Further information on this subject may be obtained from Dr P.G. Jenkins, IPCS (Fax: 4122-7914848; E-mail: jenkinsp@who.ch).

IOMC

The Inter-Organization Programme for the Sound Management of Chemicals (IOMC) was established in 1995 by UNEP, ILO, FAO, WHO, UNIDO and the OECD (the Participating Organizations), following recommendations made by the 1992 UN Conference on Environment and Development to strengthen co-operation and increase international co-ordination in the field of chemicalsafety. The purpose of the IOMC is to promote co-ordination of the policies and activities pursued by the Participating Organizations, jointly or separately, to achieve the sound management of chemicals in relation to human health and the environment.
Copper: Essentiality and Toxicity

Copper is an essential trace metal for humans, yet at high levels it is toxic.

Copper and its compounds occur naturally in the earth’s crust, thereby leading to measurable background levels in air, water, soil, foodstuffs and living tissue. Adding to the concentrations found naturally are inputs from human activities such as mining, smelting and fabrication of copper, zinc or lead, as well as electric power generation, iron foundries and municipal incinerators.

Copper metal has been used by humans longer than any other – some 15 000 years – and present worldwide production is about 11 million tonnes per year. Properties such as its durability, ductility, malleability and high thermal and electrical conductance have led to its widespread use in construction (plumbing, roofing and wiring), telecommunications, electronics, food preparation, transportation, automobile production and other industries. For centuries it has been used for decoration and in the manufacture of coins.

Copper compounds have played a major role in agriculture as fungicides, algicides and as nutrient supplements to increase food production. Copper itself has been of great benefit to public health protection through its use as a replacement for lead piping in transporting drinking-water. It inhibits bacterial growth and reduced biofilm formation within the plumbing system, both of which provide health protection to the consumer.

For decades, copper has been recognized as an essential trace metal for humans. However, concern has been recently expressed over possible copper toxicity, particularly liver cirrhosis in infants and children resulting from consumption of high levels of copper in milk stored in brass vessels. Very soft, low pH drinking-water extracted from shallow private wells, which has been in contact with copper pipes for long periods of time, can also be a source of copper toxicity.

Guidelines for the recommended daily intake for copper have been proposed over the last 30 years by the Joint FAO/WHO Committee on Food Additives (JECFA), and a provisional drinking-water guideline has been proposed by WHO in view of the widespread use of copper in water distribution systems.

In June 1996, the IPCS, with the generous support of the Commonwealth and State Governments of Australia, convened a Task Group composed of 17 experts from 10 countries to evaluate the human health and environment risks from exposure to copper and its compounds. This article summarizes the major conclusions, which will be published in 1997 as a monograph in the Environmental Health Criteria series.

In all living organisms studied, complex biological mechanisms exist that maintain trace elements, including copper, at levels that are optimum for growth and development but do not cause adverse toxic effects or lead to a deficient state. This is known as the homeostatic range, an acceptable range of intake or exposure. Nutritionists and toxicologists must work together to determine the upper and lower limits of this range. If copper intake falls below this range there will be an increased risk of copper deficiency, and if it exceeds the upper limit there will be increased risk of copper toxicity.

### WHO guidelines on human exposure to copper

<table>
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<tr>
<th>Exposure</th>
<th>Population</th>
<th>Normative requirements (mg/day)</th>
<th>Maximum level</th>
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<tr>
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</tr>
<tr>
<td>Diet1</td>
<td>child (6-10 years old)</td>
<td>0.75</td>
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<tr>
<td></td>
<td>adult male</td>
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<td>12.0</td>
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<tr>
<td></td>
<td>adult female</td>
<td>1.15</td>
<td>10.0</td>
</tr>
<tr>
<td>Total exposure2</td>
<td></td>
<td></td>
<td>30.0</td>
</tr>
<tr>
<td>Drinking-water3</td>
<td></td>
<td></td>
<td>2 mg/litre</td>
</tr>
</tbody>
</table>


### Exposure Pathways

Humans may be exposed to copper from air (dust and particulate), soil, food and water, and in the workplace. However, for the general population the major route of exposure is oral. The total intake is usually between 1 and 2 mg/day, and occasionally exceeds 5 mg/day with no visible signs of toxicity. Over 90% of this intake is from food. Drinking-water provides between 0.1 and 1.2 mg/day depending on the physico-chemical properties of the water. Most studies have found daily food intakes to be at the lower end (1.0 mg) of the range, particularly in the USA and...
Copper in drinking-water

Copper piping and brass fixtures are widely used in drinking-water systems. Leaching of copper from these materials will only be significant when the water is extremely soft and acidic and is left in contact with the metal for hours. With non-corrosive water, copper levels in fresh drinking-water rarely exceed 0.5 mg/litre and are usually closer to 0.1 mg/litre. Drinking-water provides about 0.1-0.2 mg of the human daily intake, but may provide 10 times this amount when “aggressive” water that has been left for hours in copper pipes is consumed. Levels of copper in excess of 1 mg/litre may interfere with the intended uses of the water by leading to staining of laundry, hair, and plumbing fixtures, and levels of 5 mg/litre or more impart a bitter taste to drinking-water.

Europe where such intakes are about 20% below recommended levels (1.2 mg/day). If workers were exposed to a copper level of 1 mg/m³ air, a widely accepted standard, daily intake by inhalation would be about 8.5 mg copper. However, in well-controlled work environments the intake will be much lower.

Health Effects

There is no single specific indicator of copper deficiency. Many of the symptoms seen in copper-deficient animals also occur in humans. These include hypochronic anaemia, neutropenia, hypopigmentation, abnormal bone formation, vascular abnormalities, and uncrimped or steely hair.

In the general human population, clinically evident copper deficiency in adults is rarely found. However, the suboptimal intake of copper in some regions of the world may lead to induced copper deficiency in individuals taking supplements of zinc, ascorbic acid or iron, given the known nutritional interactions. Copper deficiency may be a risk factor in the pathogenesis of cardiovascular disease.

In infants low birth weight, frequent episodes of diarrhoea, and recovery from protein energy malnutrition are all factors that may lead to copper deficiency.

Ingestion of excess copper is infrequent in humans. When it occurs it is usually from consumption of contaminated beverages of drinking-water, or from the deliberate ingestion of large quantities of soluble copper salts (e.g., copper sulfate). The target organ is the gastrointestinal tract and the responses reported include nausea, vomiting and diarrhoea. The copper concentrations in drinking-water probably need to be several mg/litre to cause gastrointestinal illness.

The primary effect of long-term exposure to excess copper is metal accumulation in the liver, leading to structural and biochemical changes including liver cirrhosis. Wilson’s disease is the most commonly inherited (1 in 30 000) disorder of copper metabolism, and results in liver copper accumulation and toxicity. Chronic liver disease resulting from decreased bile flow is the most common cause of copper accumulation in the liver of children and adults. In these cases copper does not appear to be the primary cause of hepatic injury.

Information gaps

A summary of the major conclusions reached by the Task Group is given in the box. It is evident that this group of experts did not feel that available data from studies in humans or experimental animals permitted an estimation of the maximum exposure level in humans at which adverse health effects would be found. They did, however, recommend areas for future study that should provide such information. These will be presented in the EHC monograph, as well as in the internal report PCS/EHC 96.28 available now from the Director, IPCS.

Information gaps will continue to be developed using an uncertain database and perhaps inappropriate methodology. Regulatory strategies based on such numbers may not provide any added public health protection, thus wasting precious public health resources worldwide, and may in fact result in added risk when substitute materials are recommended that have the potential to produce other, perhaps more toxic, contaminants in food and water.

Further details of all these activities may be obtained from Dr G. Becking, IPCS/IRRU, World Health Organization, P.O. Box 12233, Mail Drop EC-07, Research Triangle Park, NC 27709 USA (tel: 919 5417537; fax: 919 5412712; Email: IN%"Foster@NIEHS.NIH.GOV"). An article on trace elements in the environment will appear in the next issue of IPCS News.
For chemicals to be produced, used and eventually disposed of safely, a reliable system for classifying and labelling chemicals and producing data sheets is essential. A number of systems already exist and it is harmonization of these systems that is now needed.

This need was recognized as long ago as the 1950s, when the UN Recommendations on the Transport of Dangerous Goods established a basis for labelling chemicals for all modes of transport. In 1992 the Earth Summit in Rio recommended that “a globally harmonized hazard classification and compatible labelling system, including material safety data sheets and easily understandable symbols, should be available, if feasible, by the year 2000”.

Also in 1992 the IPCS was given overall responsibility to promote and oversee work on harmonization, while several other international organizations agreed to work on the harmonization of specific classification categories. For example the International Labour Organisation was given the task of developing harmonized criteria for physical hazards, such as corrosivity and flammability, while the Organisation for Economic Co-operation and Development assumed responsibility for human and environmental toxicology.

Areas for harmonization activities

1. Health hazards
   • acute health hazards criteria
   • long-term health hazards criteria
2. Physical hazards
   • flammable materials
   • reactive materials
   • compressed gases
3. Environmental hazards
   • aquatic environment
   • soil and terrestrial environment
   • atmospheric environment
4. Hazard communication
   • labelling
   • chemical safety data sheets
   • training in hazard communication
5. Special hazards
   • radioactive materials
   • hazardous wastes
6. Methodology
   • methods for classifying mixtures
   • procedures for determining hazard priority for labelling purposes

The potential benefits of a harmonized system are that it will help protect mankind and the environment by establishing an international system for hazard communication and by providing a framework for those countries without an existing system. Furthermore it will reduce duplication in the testing and evaluating of chemicals and facilitate international trade in those chemicals whose hazards have been properly assessed.

What is the current status of the harmonization process? Significant progress has been made on toxicity to the aquatic environment and also for both reactive and flammable substances. Work has started on harmonizing procedures for classifying mixtures of chemicals, and on an “inventory” report on hazard communication.

The technical criteria for classifying and testing should be virtually completed by the end of 1997. Progress has been assisted by increases in the technical input of industry into the harmonization process and in the number of different countries that have become involved.

Further information on this subject can be obtained from Mr I. Obadia, Occupational Health and Safety Branch, International Labour Organisation (Fax: (4122) 7996878; Email: obadia@ilo.org).
Recent publications

**Environmental Health Criteria**
- 164 Methylene chloride
- 171 Diesel fuel and exhaust emissions
- 180 Principles and methods for assessing direct immunotoxicity associated with exposure to chemicals
- 181 Chlorinated paraffins
- 182 Thallium
- 183 Chlorothalonil
- 184 Diflubenzuron
- 185 Chloroendic acid and anhydride

**Health and Safety Guides**
- Users’ Manual for the IPCS Health and Safety Guides
- Joint FAO/WHO Expert Committee on Food Additives (JECFA)

**Forthcoming Meetings**

**Environmental Health Briefing Pamphlets**

Supported by communication and linguistics specialists, the best available experts have written a series of concise, technically accurate pamphlets. They aim to inform you of the nature of environmental risks, and advise you on the different options open to you and their costs. They will help you to define environmental strategies. They will also help you to quickly assess a situation on a particular aspect of environmental health, and so, constitute valuable decision-making tools.

Quality of urban air, continual provision of safe drinking-water, waste management, urban planning... these are some of the challenges that confront local authority decision-makers on a daily basis.

The information available is scantly, sometimes unreliable, and often incomprehensible to the layman.

Nevertheless, decisions have to be made. These pamphlets, being readily accessible to a wide range of people, will become a valuable tool for local authorities and their technical services. About a hundred pamphlets, some translated into 20 languages, should be available by the end of 1997.

To obtain copies of pamphlets, the leaflet inserted in this newsletter should be completed and returned to World Health Organization, Regional Office for Europe, Environmental Planning and Health Unit, 8 Scherfigsvej, DK-2100 Copenhagen, Denmark.

It should be noted that these meetings are being attended by specifically invited experts only.
Letter from a reader

Women and Chemicals: A Vietnamese Experience

I would like to add an aspect of women and chemicals not mentioned in your interesting article [IPCS News, Issue 9, June 1996]. The following story is a common phenomenon in my very poor village in VietNam.

Dau Tieng, Song Be province, 90 km from Ho Chi Minh city, is an agricultural village. Pesticides can be found in every household. Since most of the villagers are aware of the toxicity of pesticides, some of them, usually women, who are suffering heavy life pressures, have used pesticides to kill themselves.

So far in this village, there has been only one known male victim who committed suicide by pesticide. First he killed his wife, then forced his children to drink pesticide and killed himself by the same method.

This story is common not only in Dau Tieng but also in many other remote areas in southern VietNam.

Obviously, to prevent these suicides requires a lot of effort. Since health education for women is still a new concept in rural areas of VietNam, information dissemination via local radio and television stations is considered the best method for our remote community.

I wrote this not only as a reader who is interested in women and the environment but also as a person who has suffered the loss of two relatives who used pesticides to commit suicide: both of them were teenagers, 9 and 14 years old.

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