

Steelworks and foundries are a major source of damage to the environment. Causes of damage include solid, liquid and airborne pollution, high noise levels and heat.

Some sources of pollution, like landfill sites or damage to water ways are difficult to cover up; the effects on vegetation and animal life are obvious effects.

Others such as the effect of dust and fume from a steelworks or foundry on the health of people living nearby are more difficult to establish.

Often local people work in the steelplant too, or the area around a steelworks becomes an area of housing for poor people whose health is in any case worse than in the general population. The cigarette smoking habits of residents or the presence of other factories or major roads or domestic fuel burning are common reasons given for the poor health of people living around steelworks.

But there have now been a number of scientific studies which show convincing effects on chest disease patterns amongst people living close to steelworks and foundries. The most convincing showed a dramatic

fall in admissions of children with asthma and pneumonia to a local hospital for childhood asthma during a year-long strike at a steelmill in Utah, USA. There was a sharp drop in airborne levels of respirable dust particles in the area. Other studies have reported more deaths than expected from bronchitis, chronic obstructive lung disease and certain cancers around steelplants.

Measuring environmental pollution

Environmental measurements often show relatively low levels of dust and gaseous pollution. However the standards for environmental pollution are much lower than workplace standards - because residents are generally exposed for more hours each week than workers, and because particularly susceptible groups like children, or adults with lung and heart conditions may live nearby. Also the mixtures coming out of the steelworks and the effects of sunlight on airborne pollution create complex mixtures which are very hard to assess. The standards set are therefore precautionary - they allow a safety margin.

World Health Organisation (WHO) carcinogenic risk estimates based on human studies.

Substance	Exposure Level	IARC Group	Unit risk	Site of tumour
Arsenic	1 $\mu\text{g}/\text{m}^3$	1	3 x 10 ⁻³	lung
Benzene	1 $\mu\text{g}/\text{m}^3$	1	4 x 10 ⁻⁶	blood (leukaemia)
Chromium (VI)	1 $\mu\text{g}/\text{m}^3$	1	4 x 10 ⁻²	lung
Nickel	1 $\mu\text{g}/\text{m}^3$	2A	4 x 10 ⁻⁴	lung
Polynuclear aromatic hydrocarbons (carcinogenic fraction)	1 $\mu\text{g}/\text{m}^3$		9 x 10 ⁻²	lung

Table shows the additional lifetime risk of cancer for a lifetime of exposure at 1 $\mu\text{g}/\text{m}^3$ in air.

Risk Estimates for Asbestos

Concentration	Range of lifetime risk estimates	
Asbestos 500 F / m ³ (0.005 F/ml)	10 ⁻⁶ – 10 ⁻⁵	(lung cancer in a population where 30% are smokers)
	10 ⁻⁵ – 10 ⁻⁴	(mesothelioma).

WHO Air Quality Guidelines

Substance	Time-weighted average	Averaging time
Cadmium	1 - 5 ng/m ³	1 year (rural areas)
	10 - 20 ng/m ³	1 year (urban areas)
Carbon monoxide	100 mg/m ³	15 minutes
	60 mg/m ³	30 minutes
	30 mg/m ³	1 hour
	10 mg/m ³	8 hours
Formaldehyde	100 µg/m ³	30 minutes
Hydrogen sulphide	150 µg/m ³	24 hours
Lead	0.5 - 1.0 µg/m ³	1 year
Manganese	1 µg/m ³	1 year
Nitrogen dioxide	400 µg/m ³	1 hour
	150 - 200 µg/m ³	1 hour
	100 - 120 µg/m ³	8 hours
Sulphur dioxide	500 µg/m ³	10 minutes

Achieving changes

Improvements in plant design which benefit workers frequently bring benefits to local communities as well. Workers' pressure on US coking plants following publication of the evidence for coke oven cancers in the late 1970s brought about improvements in benzene and polycyclic aromatic hydrocarbon emissions into the air of up to 85%.

The difficulties of carrying out studies should not put people off. A study needs to be large, preferably using a questionnaire which is tried and tested, and involve a comparison - with an area of similar housing without a polluting factory nearby, or with a period when pollution was not occurring (a strike, shut-down, or before the plant was built).

Plans by the South African steel

company, ISCOR, to build a steelworks at Saldanha Bay in Cape Province have been closely monitored by environmentalists. Concern was expressed about the lack of a suitable study of the environmental impact of the steelworks. The assessment carried out assumed a much smaller plant than was finally proposed. Environmentalists were worried that the COREX technology was to be used because of the failure of ISCOR, the South African company to provide emissions data from its Pretoria COREX plant. Fishermen described the difficulties they already had in finding fish stocks off the coast where the plant was planned. The benefits for local unemployment were also found to be less than predicted because so many of the 600 employees who would be

required would require skills not available locally.

Many technologies have been devised to reduce air and water pollution from steelworks and foundries and to reduce the amount

of solid waste tipping which is required. (see table). It is estimated that pollution control costs are only 1-2% of total production costs once installed.

Practical solutions to environmental problems

Heat	Recycling of heat
Wastes	Reuse as fuels, enclosed systems, direct reduction, Separation of iron from other metals
Solvent based materials	Water-based substitutes
Dust and fumes	Containment (material handling, concast, etc) Stockpiles (coating agents to control blown dust, enclosure)
Noise	Soundproofing, physical barriers.

Best available technologies for control of environmental pollution

Sintering	Ore preparation	D
	Scrubbing	Sulphide precipitation, F and activated carbon adsorption
	Cooling and rinsing	R, B (S+SF)
Pelletisation		D
	Gas scrubbing: dust	B (S+SF), R
	Gases	R, C, S, F
Coking plant	Waste water	Biological treatment
Blast furnace	Tapping, iron-making	D
	Gas-scrubbing	R, S, activated sludge treatment, F
	Cooling	B (S+SF), R
Basic Oxygen Steelmaking	Converter gas	D
	Scrubbing	B (C+F), C, S, R
	Cooling	B (S+SF), R
Electric arc furnace	Furnace gas	D
	Scrubbing	B (F), C, S, R,
	Cooling	B (S+SF), R
Concast/Ingot making	Cooling	C, S, Flotation, SF, Biological polishing, R
Rolling	Rinsing:hot	C,S, flotation, SF, Biological polishing, R neutralisation, C, Oil-skimming, micro/ultrafiltration
	Rinsing:cold	
Pickling	Spent acids	Chemical systems for recovery
	Rinsing	Cascade rinsing and effluent treatment.

B: Blow down water treatment, C: Chemical precipitation, D: Dry gas cleaning (cyclones+) electrostatic and fabric filters, F: Filtration, R: Recirculation, S: Sedimentation, SF: Sand filtration.

From European Commission, 1996.

	<i>Air</i>	<i>Water</i>	<i>Solid wastes</i>
Sintering	Sulphur dioxide, nitrogen oxides, dioxins	Heavy metals, dioxins	
Pelletsing	Sulphur dioxide, nitrogen oxides, hydrogen fluoride, dusts	Fluorides	
Coke Ovens	Nitrogen oxides, sulphur dioxide, benzene, toluene, xylene, polycyclic aromatic hydrocarbons, coal dust, coke dust	Phenol, ammonia, cyanides	
Blast Furnace	Carbon monoxide, sulphur dioxide, silica, ore dust, coke dust, slag dust (containing, iron oxide, zinc, lead, phosphorus)	Sulphur compounds, zinc, lead, cadmium, ammonia	Slags
Basic oxygen			
Steelmaking	Carbon dioxide, iron oxide	Zinc, lead, chromium	Slags: see blast furnace
Electric arc furnace			
Concast	Nitrogen oxides, metal dusts according to scrap source and alloy type.	Sulphates, fluorides	Slags
Rolling		Oil, grease, chromates, acids, detergents	Sludge, containing oil
Pickling	Metal dusts, according to alloy type, sulphur dioxide	Oil/water mixture oil, iron oxide, dusts	Metal dusts
	Acid fumes	Sulphur compounds, nitric acids, hydrochloric acid, chromates	Sludges
		Slag: calcium oxide, magnesium oxide, aluminium oxide, iron oxide, phosphorus compounds, silicates and silicon dioxide.	

Environmental pollution from steel works

- Abrasive:** having the capacity to wear away other material (e.g. grinding wheels).
- Acid linings:** refractory materials such as silica-containing rock, ganister, or silica brick which have an acid reaction with substances in the melt.
- Acute:** an immediate, short-term response.
- Aesthesiometer:** a device for testing the sense of touch.
- Airline:** a pipe supplying air to workers' breathing apparatus.
- Airways resistance:** the resistance of the airways in the lung to flow of air during intake of breath.
- Allergic:** an unusual sensitivity to a substance (the allergen) resulting from the response of the body's immune system following exposure.
- Antibiotic:** a chemical substance found in nature which has a special capacity for killing bacteria.
- Arc-air gouging:** removal of material from a casting by creating an electric arc which melts surface metal.
- Asphyxiant:** a substance the amount of which can cause breathing to stop because of lack of oxygen in the atmosphere.
- Atopic:** an individual with an inherited tendency to react with increased tendency to be *sensitised* by substances.
- Bacteria:** a particular class of minute single-celled life-forms which includes the organisms causing many common infectious diseases.
- Bactericide:** any method (particularly a chemical) of killing bacteria.
- Blanching:** becoming white.
- Blood-gas measurements:** measurements of oxygen and carbon dioxide present in the blood.
- Blood pressure:** the pressure of the blood on the walls of the blood vessels leading from the heart.
- Bronchodilators:** drugs which open up (dilate) the main airways of the lung.
- Breakthrough times:** time taken before a chemical present on one side of a protective material (e.g. glove) penetrates to the other side.
- Capacitors:** electrical components which store an electric charge.
- Capsule:** fibrous material containing fluid in a joint (e.g. knee).
- Carcinogens:** agents (mainly chemicals) capable of causing cancer.
- Cartridge:** replaceable container filled with filtering material used in a face mask.
- CAS, CAS-OB:** Compositional Adjustment by Sealed Argon bubbling (or Oxygen-Bubbling) - a ladle treatment for steel used in the production of strip steel.
- Chemotherapy:** a method of treating a disease (e.g. cancer) with chemicals.
- Chest X-ray:** use of medical X-rays to produce an image of the lung tissue.
- Chlorinated hydrocarbons:** organic chemicals containing chlorine as well as hydrogen and carbon.
- Chromosome:** the chemical structure present in each cell which carries the genetic information which determines the individual characteristics of an organism.
- Chronic:** long-term.
- Coal-tar pitch volatiles:** volatile

- organic substances present in the sticky pitch remaining after distillation of coal.
- Combustion:** burning.
- Conditioning cream:** cream used to restore moisture content to the superficial skin layers (also called moisturisers or emollients).
- Cor pulmonale:** enlargement of the right side of the heart following damage to the lungs.
- Core:** a preformed shape made from sand and binding material which is held in place within a mould to create the internal shape of a casting.
- Corebox:** structure having a cavity the shape of the core, used to make the core in.
- Cupola:** a 'bell-shaped' furnace used for the production of iron in foundries.
- Cyclone:** a method of separating dust from gas or liquid by making the gas or liquid rotate.
- Decibel:** a unit of sound-pressure such that each increase in sound-pressure(noise) level of ten times counts as an increase of ten decibels.
- Depression:** a prolonged mental state of increased feelings of sadness or despair.
- Deseamers:** people who remove die and mould blemishes from cast or stamped parts.
- Desulphuriser:** a chemical used to remove sulphur from molten steel.
- Dedusting (wet and dry):** a method for removal of dust from exhaust gases.
- Dies:** the mould used in die forging or die pressing, also the tool used to reduce a wire thickness by pulling a rod or wire through it.
- Direct reduction:** a method of separating iron from its ore without use of coke.
- Disc (vertebral):** a fibrous body occupying the space between two bones in the backbone.
- Disposable (mask):** a mask the whole of which is designed to be used then thrown away after a period of use.
- DNA:** the chemical, deoxyribonucleic acid, which forms the information bearing structure of the chromosome.
- Electromagnetic:** electric or magnetic fields found in motors, electric arcs, etc.
- Electroslag refining:** a technique for refining of steel where the ingot is used as an electrode and progressively melted away in a controlled atmosphere.
- Electrostatic:** electrically charged.
- Emulsion:** a material in which one liquid is dispersed (broken up into droplets) in another, e.g. oil in water in emulsion paints.
- Extension:** the opposite of flexion: extension of the fingers or hand move the fingers or hand in a direction away from the palm: extensor tendons are involved in this movement.
- Fettling:** the process of cleaning castings.
- FEV₁, FVC:** Forced Expiratory Volume in one second (FEV₁) is the amount of air breathed out in the first second of a forced breathing test. Forced Vital Capacity (FVC) is the total amount of air breathed out in a forced breathing test.
- Fibrogenic:** a substance which can cause formation of fibrous tissue in the lungs.

- Fibrosis:** formation of fibrous tissue (e.g. in the lungs).
- Fibrous (tissue):** tissue made of fibres of protein or other large molecules (for example collagen), e.g. in scar formation.
- Filters:** a barrier used to prevent passage of some chemicals while allowing passage of others flux - a substance used to ease the fusion of metal objects, during melting or welding of steel foreign bodies (in the eye) - any small object entering the eye; dust, scrap of metal, etc.
- Flexion:** movement of fingers or hand in the direction of the palm: flexor tendons are involved in this movement.
- Frequency:** the number of times an continuously reoccurring event occurs in a unit of time; e.g. sound-pressure changes in a pure sound.
- Full-face (mask):** a mask covering the mouth, nose and eyes.
- Fume:** solid particles generated by chemical reactions or condensed from gases, usually after a molten substance has become volatile.
- Furan:** a specific group of chemicals containing rings of carbon and oxygen atoms.
- Galvanising:** a process by a thin layer of zinc is deposited on iron or steel.
- Gas:** a substance in its most dispersed state; as compared with a solid or liquid.
- Gas transfer:** transfer of gases between two media, e.g. between air in the lungs and the blood in lung tissue.
- Greensand:** a sand used in foundry moulding which is used while damp.
- Half-face (or half-mask):** a mask covering nose and mouth and held in place by adjustable straps.
- Herniation:** outpushing of tissue through an abnormal opening.
- HBEL:** health-based exposure limits.
- Hood:** a partial enclosure of the space over a source of pollution designed to capture the substances being generated.
- Hydraulic:** transmission of pressure through a fluid using pipes.
- Incremental:** bit-by-bit.
- Induction (furnace):** heating by creation of electrical currents within the metal charge.
- Industrial hygiene:** the study of the industrial environment and its effects on the living body.
- Inflamed/inflammation:** a response to injury or damage to tissues in which the tissues become red, hot, painful and frequently swollen.
- Knockout:** removal of cores from castings by knocking them, shakeout - similar process for removing casting from mould.
- Ladle:** lined metal container used to transport molten metal.
- Leukaemia:** a malignant (cancer-like) disease of the blood-forming organs of the body, in which there is over-production of white blood cells.
- Lethargy:** a feeling of tiredness or mental 'heaviness'.
- LEV:** local exhaust ventilation - removal of contaminated air at source.
- Ligament:** a fibrous structure connecting bones and cartilages, and holding them in place.
- Lipoid pneumonia:** *pneumonia* caused by breathing in oil vapour.

- Lost wax:** technique for making patterns using a wax pattern on which a thin layer of refractory material is deposited. The wax burns off as the molten metal is poured.
- Lubricants:** substances used from reducing resistance between two surfaces.
- Malignant:** changes in the body (particularly specific kinds of cell) which tend to become worse and without reversal to end in death.
- Metallurgists:** specialists in the science of metals.
- Mucous membranes:** the surface of tissues which are covered by a slimy substance produced by the body (e.g. linings of airways, digestive system, etc).
- Nasal septum:** the barrier separating the two airways in the nose.
- Non-malignant:** the nature of cells or tissues not affected by malignant changes.
- Notch (audiogram):** the shape of the ear's response to sound on an audiogram when the sound level required for hearing at one frequency or more is greater than that on frequencies to either side.
- Oedema:** swelling of tissue produced by increased amounts of fluid between the cells in the tissue.
- OES:** occupational exposure standard.
- Offtakes:** an opening through which gases are removed.
- Orinasa (mask):** a mask covering both mouth and nose.
- Osteoarthritis:** degeneration of the tissues of the joints (bone and the covering of the bone).
- Parkinsonism:** a disease affecting the brain which has several different causes all showing signs of tremor (shaking), and rigidity.
- Particulate:** composed of particles.
- Parting compound:** substance used to improve separation of casting from mould, or mould from pattern.
- Patenting:** method of cooling of wire in a bath of lead.
- Peak flow meter:** a medical device used for measuring the most rapid air flow rate during a forced breathing test.
- Phlegm:** a sticky liquid produced by special cells lining the main airways of the lung.
- Photosensitisation:** special sensitivity of the cells of the skin to light (e.g. after exposure to a particular chemical).
- Pitch:** a dark-brown or black, shiny substance left after more volatile substances have been removed from coal or oil.
- Pneumonia:** inflammation of the lungs in which the lung tissue becomes 'consolidated' with fluid.
- Pneumonitis:** inflammation of the lungs.
- Pleural plaques:** flat, hardened areas of the lining of the chest cavity (the pleura) which are believed to be a response to the presence of asbestos fibres.
- Pleural thickening:** a thickening of the lining of the chest cavity caused by asbestos fibres or past infections.
- Polycyclic aromatic hydrocarbons (PAHs):** chemicals composed of a skeleton of interlocking rings of carbon and hydrogen atoms.

- Post-traumatic shock:** psychological response to trauma (a sudden damaging event).
- Pressure-demand:** describes a respirator which supplies air under positive pressure as it is required.
- Progressive:** a disease process which continues after the immediate cause is removed.
- Quenching:** rapid cooling.
- Radiotherapy:** method of treatment involving exposure of tissues to controlled doses of ionising radiation (radioactive emissions).
- Ramming:** compacting moulding sand around a pattern.
- Raynaud's Phenomenon:** a condition in which blood supply to fingers or toes is cut off from time to time, with resulting blanching. R.P. can be a sign of several different diseases, or an inherited tendency or Hand-Arm Vibration Syndrome.
- Refrigerant:** chemical used in condensation cycle in refrigeration plants.
- Restrictive:** description of lung disease in which the usable lung volume is reduced, typically by lung fibrosis.
- Relapse:** occurrence of a more severe form of an illness again after a period of improvement.
- Respirator, respiratory protection:** any personal protection device designed to provide a worker with a purer form of air than that in the immediate working environment.
- Rheumatoid arthritis:** a chronic disease mainly involving inflammation of the joints, of unknown cause.
- Rhinitis:** inflammation of the mucous membranes of the nose.
- Scarfing:** removal of scale and surface metal from ingots, billets and blooms.
- Scrubber:** a device for removal of pollutants from air using water.
- Sensitisers:** chemicals with the special property that an exposure can create changes which mean that later responses (e.g. of skin, lungs, or nose) are much greater than the first response.
- Sensitive:** particularly likely to respond.
- Sensorineural (deafness):** involving the nerves by which the responses of the ear are sent to the brain, and analysed.
- Siderosis:** lung disease seen in workers heavily exposed to iron and iron oxide dust, in which the chest X-ray shows that material has been deposited in the lung. Siderosis is not thought to be the cause of changes in lung function where there is no other airborne pollutant present.
- Sintering:** joining particles together by heating without complete melting (e.g. ice cubes in a bowl forming a single piece of ice).
- Solvent:** one chemical capable of dissolving another.
- Specific:** having a special nature.
- Spirometer:** medical testing equipment for measuring air flow rates and volumes during breathing.
- Steroids:** a group of fat-based chemicals which normally function as chemical messengers in the body, and can be used as drugs, for example to reduce inflammation or increase growth.

Supplied-air (respirator): personal protection which supplies clean air to the worker.

Syndrome: a pattern of related signs of illness.

Taphole: opening in a melting furnace from which molten metal is tapped into a ladle.

Tendons: a fibrous structure by which a muscle is attached to another structure, for example, to a bone.

Threshold: the level at which the body's response is first noted.

Top powder: material added to the top of ingot moulds after pouring molten metal to control cooling.

Transformers: electrical equipment for altering voltages in power supplies.

Tremor: shaking.

Tuyeres: an opening in the cupola or blast furnace lining through which air is forced.

Vibration: a repetitive movement of an object (e.g. a surface) with a special frequency and strength.

Volatile (substance): a substance which evaporates (changes from liquid or solid to vapour or gas) at ordinary temperatures.

Volume: a measurement of space.

White spirits: a commercial mixture of varying composition containing toluene, xylene and other organic solvents.

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