IMPACT OF FOSSIL POWER PLANTS ON AIR QUALITY

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Kendal is the latet operating Power Station of Eskom's fleet of six-unit stations. Situated on the Bombardie Cologne coalfield 50 km south-west of Witbank, it will eventually comprise 6 natural-daft dry-cooled boiler/turbo generator units of 686 MW each. The first unit is in commercial operation, and on completion the 4000 MW will be the largest power station in the world. It's 6 enormous cooling towers each 17 000 m^3 of concrete are among the world's largest structures. Bev Lawrence is head of a group which monitors reliability, availability, efficiency and other performance parameters, recommending and implementing actions to enhance or improve these.

ABSTRACT

South Africa has abundant supply of coal, about half being used in generation of electricity. Use of low grade high ash coal results in about 25% leaving boilers as PFA but ESP's lowers quantity emitted to air considerably.

Lower sulphur coal increases ash resistivity, inhibiting precipitator effectiveness. Various solutions tested by Eskom through the 80's include electrical improvements and ash modification. SO_3 injection equipment is effective at two Eskom stations in reducing dust emission to acceptable levels. General perception of poor dust emission is a stack that has visible emission. This could be a subjective view without real basis.

Gas emissions include vast volumes of SO_x and NO_x, with no steps taken to attenuate. There is obviously a difference between high level and ground level phenomena. It was previously assumed that emission of pollutants via tall stacks above inversion layers into the jet-stream would avoid pollution problems. This does not appear in practice to have resulted, as low level haze appears to be increasing, and impact of high level gas emission is now being investigated. Installation of gas removal plant may help the air quality, but may be unaffordable.

Greater demands for wealth and jobs results in greater industrialisation, with accompanying pollution products. Also, provision of living wages and housing scheme benefits has seen development of whole new black residential areas where coal is not burned, giving clean air living areas for these people and their neighbours.

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The people of South Africa are blessed with an abundant supply of many valuable minerals, including large deposits of coal. This is of variable quality over the coal fields and in the different seams. The bulk of the higher quality coal is exported, but the remainder is mined and marketed at relatively low prices. Hence the consumption within South Africa is very high, about half being used in the production of electricity, with the majority being utilized in Eskom's many power stations (64,5 Mtons in 1988).

The prevailing national policty is to wash and export the higher quality coals, yielding a product of typically 7 to 8% ash. The poorer quality of steam coal is burnt in Eskom power stations, where the ash varies from 15 to 50% with an average value of about 25%. This is emitted from our Pulverised Fuel fired boilers in the form of fly-ash, or P.F.A., a fine incombustible with particles ranging from sub to 50 micron in size, the majority falling in the 10-20 micron range. Some 15 Mton of P.F.A. leave our boilers ech year, and the considerable impact this would have on our air is attenuated by the installation of Electrostatic Precipitators. These devices pass the gas laden dust between alternating rows of discharge wires and collecting plates having a large electric field between them. This causes the dust particles to become electrically charged, and migrate towards and adhere to the collector plates, from where it is removed and stored in ash dams or dumps.

As a precipitator can never be fully 100% efficient, a quantity of dust will not be collected, but will pass through the ESP, and be discharged via the chimney to atmosphere. When our earlier stations were planned, air pollution in SA had not reached the prominence it now enjoys, and precipitators were specified by Eskom having relatively low efficiencies, e.g. 96% Hendrina 6 to 10. This allowed 4% of dust produced to escape to atmosphere. Over the years this kind of emision has proved unacceptable, and considerably higher efficiencies are now being specified by Eskom. Lethabo Power Station, being in the extremely sensitive Vaal Triangle, has a specified performance of 99,88%. This has necessitated the world's largest precipitators, with a total plate area of 190 000 m^2, and specific collecting area of 200.

One of the elements found in coal is sulphur, and this produces a lot of problems for mankind. When the coal is burnt, the sulphur is oxidised creating sulphur dioxide gas, with the unpleasant smell so well known to residents of coal-mining areas. This further oxidises in the atmosphere to sulpher trioxide gas, which combines with moisture to form sulphuric acid. It is this feature together with another gas, nitrous oxide, which has given rise to the well-known phenomenon of acid rain.

But is also has an interesting effect on the operation of the precipitators. The sulphur content of the coal has a direct and marked effect on the electrical resistivity of the fly ash produced. A low-sulphur coal will yield a high-resistivity ash, which builds up on the collector plate as an insulating barrier layer. The electrical charge on the particles does not leak off, and the electrical field between discharge and collector is reduced, with accompanying loss

of efficiency. This problem has plagued many of Eskom's stations, with the result that even the relatively low specified efficiencies could not be attained in practice.

It was Kriel power station where the combined effects of large boiler capacities and high dust resistivities produced a station whose dust emision was the highest in Eskom. Some 100 000 tons of PFA were emitted annually at this station by the time it reached full capacity in the early 80's, and with the increasing focus on air quality it became Eskom's top priority in Phase II of their retrofitting enhancement program. Various tests were carried out to determine the techniques which were available to improve performance of existing precipitators. These included electrical modifications of the waveforms of the DC voltage applied to the discharge electrode. By superimposing spikes or pulses to the DC above a baseline constant voltage, some of the effects of the high resistivity, including back corona, can be partially overcome. Also various chemical conditioners were injected into the flue gas to modify the characteristics of the PFA particles. These included ammonia, tri-ethylamine and sulphur trioxide. It was the latter which proved to be both cost and spectacularly effective.

However we were at first hesitant about getting involved with the operation of chemical plants at power stations, and also about the problems of having the liquid sulphur "freeze" and jam the system. Further investigation in USA and Europe showed these fears to be groundless, and an installation was ordered in 1987 for Kriel Stack 1 - the worst emitting chimney in Eskom. This plant was commissioned in 1988 with such exceptional results that the extension option for Stack 2 was exercised. Both chimneys are now operating with full SO^3 injection, the capital outlay for which was R15 m, and the operating cost over R2m/year. The dust emission is often virtually invisible, and has been reduced by 90% to about 7 000 ton/yr.

It might be assumed that the injection of SO^3 into the boiler gas path, whilst improving the precipitator performance, would aggravate the gaseous emission of SOx. This is so, but the amount injected is from 10 to 30 ppm into a gas stream already containing about 1 000 ppm due to the combustion of the natural sulphur in coal. So the overall increase is about 0,2% which is really negligible.

Based on this success, similar equipment was ordered for another poor performance station, Hendrina. The number 1 chimney is now complete, whilst the second will be commissioned during November. Other Eskom stations are also looking at ways of reducing their emission levels, and are being addressed on a priority basis as agreed with the Department of Health.

One of the difficulties of working in the air quality area is the wide disparity in viewpoints between the environmentalists and the polluters. Like the nuclear arena there seem to be few players with sufficient insight and empathy to adopt less polarised standpoints. A typical case has surfaced at Kriel Power Station, where with the reduction in dust contents, the presence of the gaseous emission, previously shrouded by the dust, now sometimes becomes visible as a faint brownish wisp. This has led to an outcry from local residents, with allegations of being gassed, and an outbreak of lung disorders. One must assume that either the disorders are psychosomatic, or else the dust previously prevented the gas from causing problems. In either case it seems to me that there may be a good case for allowing a small amount of dust to be emitted from the chimneys. Certainly it is good for local crops, and our nasal equipment was designed to handle reasonable amounts of dust such as occur naturally. So the popular viewpoint that good air quality management is evidenced when there is no visible emission may be a subjective view, without a real proven basis.

What is becoming more relevant is the vast volumes of gaseous emissions being produced in various processes which are released to atmosphere. This, coupled with the reduction in natural clarifiers, such as produced by deforestation programs, and accompanying rainfall reduction and desertification, poses one of the greatest threats to the future of life on earth.

Power Stations emit copious quantities of gas, as oxides of both sulphur and nitrogen. At present no steps are taken to reduce these emissions, and about 1,2 Mton of SOx and 0,4 Mton of NOx are produced by power plants in SA annually. The effects of this are widely debated with considerable vehemence from both sides of the arena. Environmentalists, pointing to the occurrences overseas, and various local evidences, are contending major effects on health of persons and flora. Industrialists believe there is not yet evidence to support this view.

It would appear that the effects of these gaseous emissions create altitude dependent phenomena. Some sources of emission, such as mine tips and vehicles, are released at low level. Modern power stations are designed with tall chimneys up to 300 m, to release their emissions at altitudes above inversion layers where they should not influence ground level concentrations. At these heights the products are released into the jet-streams, from where they should be rapidly and harmlessly dispersed. Howeve it would appear as if in practice this may not b happening quite as effectively and harmlessly as wa hoped for. Observations have been made suggestin damage to pine needles in Eastern Transvaal forest increasing haze in the region, and acid rain allegations.

However these have all been subjective observations, an there are more objective investigations needed to clear understanding what it really going on. This is now in han with several bodies co-operating to gain the necessa insight.

In many countries, gas emitting processes are required be fited with attenuation equipment. Desulphurisati plants have been fitted to many power plants, and the are those who believe legislation in SA should enfo their installation here. What it not so apparent is the c implications this would hold in store for us. The h capital and running costs would add a considerable ex amount to the cost of electricity, estimated at 25-33 This would in turn push up the price of raw materials manufacture considerably, as most have large electr power components. Ultimately the cost of ev

commodity and service in SA would rise by about 25%. One wonders whether our devalued, disinvested economy could withstand this kind of shock.

Who will be prepared to accept a 25% reduction in their living standard, in a land where few can even afford electricity and other products anyway. Even if we can afford it for ourselves, is it morally right to impose it on the millions of smoke inhalers, be they smokers or township dwellers, who don't demand clean air?

The future does not seem clear (no pun intended). The people of SA are making greater demands for jobs and wealth. This can only be met by increased industrialisation, with the accompanying evils of pollution of every kind. Fortunately the air quality debate has broguth tighter legislation, increased standards of air quality, and greater commitment by industrialists. It would be hoped that by continuing with these attitudes and efforts, reasonable balance between the conflicting demands of health and wealth can be maintained. Obviously the extremists in both camps will never totally be satisfied.

But healthy dialogue must be stimulated and maintained, and this is already taking place in various forums. Industrialists need the environmentalists to keep pointing out where improvement is needed, and keep them on their toes. It is easy to be lulled by familiarity into accepting the unacceptable. And certainly the environmentalists need the products, jobs and services industry provides.

One particularly uplifting development seen in the Eastern Transvaal is the recent creation of whole new black residential areas where coal smoke is not seen. These towns comprise smart multi-bedroomed homes for industrial workers in the area, complete with gardens, garages, cars and electricity. They are the direct result of the equal opportunity policies of the industrialist employers, and are part of the revolution which is producing the new South Africa on all fronts.

But it is also true that there remain many who are unable to afford this lifestyle. And the problem of gaseous pollution of our air remains unclear and for the moment unresolved.