

THE CHANGING PATTERN OF POWER PRODUCTION AND ITS EFFECT ON AIR POLLUTION

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Introduction

At present the discussion around the world is centred on the effect of the increase in oil prices on the energy situation. This increase in oil prices has been termed an "energy crisis" but it must be realised that there is no shortage of energy, but there is a shortage of the cheap energy - oil - which because of its cheapness has been used widely and, in many instances, inefficiently. That the price of oil must inevitably increase has been realised for some time. At a Petroleum Institute Conference in June 1973 (i.e. before the increase in oil prices) the opinion was expressed that there would be a re-orientation of the price of oil to a level approximately 2 to 3 times the mid-1973 level, at which stage it would start to be economic to produce a petroleum substitute from other sources - e.g. coal (Ref. 1).

Thus the so-called "energy crisis" has resulted in attempts to move away from a dependancy on oil - a process which must of necessity take many years - and for steps to be taken to conserve energy mainly by using it more efficiently.

However other trends in energy production and utilization have been noted which although overshadowed by the oil problem, will have a greater effect on air pollution than the energy crisis.

Trends in Power Generation

The largest source of energy used today is fossil fuel, whether it be coal or oil. On a world basis oil has the largest share of the fossil fuel market because of its cheapness, and its ease of handling and combustion. For some applications, especially in the transport industry it is difficult to visualize oil being replaced by any other fuel. The

early fossil fuel energy producers had low efficiencies, but with developments in the field of power generation - especially in the field of material science - efficiencies have increased until they are now reaching their limit. Attempts are now being made to increase the efficiencies of power producers, mainly by going away from the simple thermodynamic cycles, to some type of combined cycle. The effect of such developments on air pollution are two-fold. In the first place, an increase in efficiency means a decrease in specific fuel consumption, which in turn means a reduction of air pollution on a "per unit energy consumed" basis. Secondly, some of these combined-cycle systems lend themselves to improved air pollution control especially in the area of sulphur emissions.

Concurrently with developments in fossil fuel technology, research into other forms of energy production is growing. A growth which will certainly be increased by the recent oil price escalation. Such sources as solar energy, wind energy, geothermal energy, etc. are all prospective candidates in the energy stakes. Solar energy for space-heating in buildings is an attractive concept and it is expected that this will become a common feature of buildings in the years to come. However this type of installation cannot make up more than a few percent of total energy usage and will not have any great effect on energy consumption patterns. The application of solar energy for large scale power applications, and the use of wind, geothermal, or any of the more esoteric forms of energy is not considered to be a significant source of energy for the foreseeable future.

The nuclear reactor is becoming viable in many parts of the world and will make an increasing contribution to energy production. Its effect will be to decrease air pollution by such substances as sulphur-dioxide, nitrous-oxides etc., but will increase air pollution by radioactive substances. With appropriate safeguards this should be kept within acceptable levels.

The World Situation

Over the last decade there has been a swing to oil as an energy source because of its cheapness for power-production, because of its availability as a low sulphur fuel to meet the energy needs in areas with strict air pollution requirements, and because of its convenience in the transport industry. That oil was cheap can be seen in the fact that the OECD cost index for main products increased by 50% over the period 1961 to 1971 whilst the cost of oil remained constant (Ref. 1). The hike in oil towards the end of 1973 was partly a realisation of the cheapness of oil, as well as a realisation that oil reserves were limited and production would peak. The political motives behind the price escalation were incidental to the main theme.

The increase in oil prices came at the same time as the realisation by energy producers that oil was not an unlimited commodity and that alternate sources of energy must be exploited. When considering alternative energy sources it must be remembered that it takes six years to build a fossil fueled station or a refinery, ten years to build a nuclear power station, and that to produce significant commercial plants from some new energy source operating as a pilot-plant now will take approximately twenty-five years.

Thus when considering the effect of the energy crisis the future must be considered in three parts, short, medium and long term.

In the short term, there is not very much that can be done except to intensify research in selected fields. It is possible to reduce energy imports, as is being done in many parts of the world, by fuel and energy conservation methods. It is possible to modify certain boiler installations from oil to coal or gas but this will be expensive unless the installation has been designed as a dual fuel unit. In general, such modification means a reduction in output capacity. In the medium term the tendency will be to move away from reliance on oil as a fuel and it may be expected that coal and nuclear plants will increase, at the expense of oil, for electrical power generation.

It is difficult to see on the global scale any fuel taking over dramatically from oil in the transport industry. Whilst various transport forms such as battery driven vehicles will make inroads into the internal-combustion engine market, it is doubtful whether this competition will be significant unless there is a dramatic break-through in battery technology.

Also in the medium term, one expects to see various forms of gas-from-coal and oil-from-coal plants which will make use of the vast coal reserves of the world.

On the air pollution front the energy crisis has had the effect of relaxing certain air pollution criteria. For instance last November the intention of the British Government to decrease the permissible level of lead in petrol from 0,64 mg/l to 0,55 mg/l was temporarily shelved because of the oil shortage. In the United States, the Environmental Protection Agency is reconsidering some of the limits which it applies to air pollution, and many projects for power plant and refineries which have been held up because of opposition from environmentalists, are now likely to get building permission.

The South African Situation

South Africa is fortunate in having a large reserve of low cost coal and most of its energy consumption has thus far been based on coal. Of its total energy only 24% (Ref. 4) is presently derived from oil, most of it being used in the transport section (see Fig. 1). The coal deposits are large enough for South Africa not to need to be precipitated into an expensive nuclear programme because of fossil fuel shortage. However, with the developments in nuclear technology and because of the large economies of size which can be made with nuclear plant, nuclear power will become economic with fossil fuel power especially in areas far from the coal fields. Escom has already announced that it intends to instal its first nuclear power station in the Western Cape in 1982. Nuclear Power will, it is estimated, increase to about 12% of electri-

city production in 1990 and to amounts varying in estimates from 14% (Ref. 2) to 18% (Ref. 3) in the year 2000. Thus nuclear power will not have any great effect on the country's energy demand before the end of this century, although it is expected to become the largest energy supply source soon after the turn of the century.

In view of the increasing cost of oil and because of continuing relatively low cost of electricity derived from coal, it may be expected that the electrically driven vehicle will have a growing popularity in this country, possibly more so than in countries which either rely on oil for electricity generation or where coal prices are comparable with oil costs.

From the air pollution standpoint coal will, for the short and medium term, remain the main source of pollution. Developments taking place overseas appear to be leading to a system of combined-cycle coal usage for electricity generation. This system requires coal to be gasified, the gas being passed to the combustion chamber of a gas-turbine before being passed to a waste heat boiler of a conventional steam system (see Fig. 2). This system, besides increasing the overall efficiency of the power plant lends itself to sulphur removal since the sulphur in the coal comes off as Hydrogen Sulphide, a compound which is easily removed by scrubbing.

In the area of transport, consumption of oil must decrease on a specific basis due to conservation techniques. This will not mean a decrease in overall oil consumption, but will mean that the rate of rise in oil consumption will decrease.

Effect of the energy crisis on Air Pollution

Although there is no shortage of energy on a global scale the recent rise in oil prices, and the possible threat of a politically orientated oil embargo has caused many nations to reassess their energy requirements and to attempt to decrease their reliance on oil. These moves have already led to an assessment of the efficiency of energy utilisation and moves to conserve energy. Where it is being found possible to re-

duce energy consumption without affecting production, this is leading to a decrease in pollution and especially to a decrease in air pollution. However, normal economic growth will ensure that this decrease is not an absolute one but a decrease in the rate of rise of energy consumption and pollution.

The energy crisis has also meant that the regulatory authorities are taking a second look at some of the control measures which would result in greater energy usage. From this point of view it could mean that air pollution will increase. However, it is doubtful whether any drastic changes would result and in South Africa the results would be insignificant.

Also in the short term, small oil-burning plant may be converted to coal-burning, and whilst this would have little effect on sulphur and nitrous oxide emissions, it may have an affect on particulate-matter emissions which would increase. This effect would be most noticeable in the coastal areas where the economics of coal transport have resulted in many oil-burning plant being installed.

In the medium term, e.g. before 1990, a significant trend towards battery or other unconventional vehicles may come about. This would decrease urban pollution at the expense of pollution at the pit-head stations in the Eastern Transvaal. Since conditions at the latter are better controlled, and the pollution affects less people, the overall pollution level can be said to be reduced.

The advent of the combined cycle will lead to increased efficiencies and much reduced pollution levels.

In the long term, nuclear power stations will take over as the major source of energy and will lead to dramatic reductions in pollution levels.

Summary

In the South African context it is not expected that the energy crisis - or rather the shortage of cheap oil - will have much effect on air pollution levels. The main result will be a move towards more efficient methods of energy utilisation, especially of oil utilisation. More efficient uses of energy will mean a reduction in air pollution but such reductions would only be transitory since normal economic growth would soon overtake them.

In the medium term, the adoption of a combined cycle will mean an increase in the efficiency of energy conversion. Also in the medium term it is postulated that there will be an increase in vehicles driven by means other than the petrol driven engine.

It should be remembered that the time from prototype to a significant scale commercial application is, in the power generation field, of the order of twenty five years and it is thus doubtful if any radically new forms of energy producer will make an impact on either the energy or air pollution field before the end of the century.

In the long term, nuclear power will become the largest energy source and will dramatically reduce the presently known forms of air pollution. However, air pollution by radioactivity will, by that time, require serious consideration.

References

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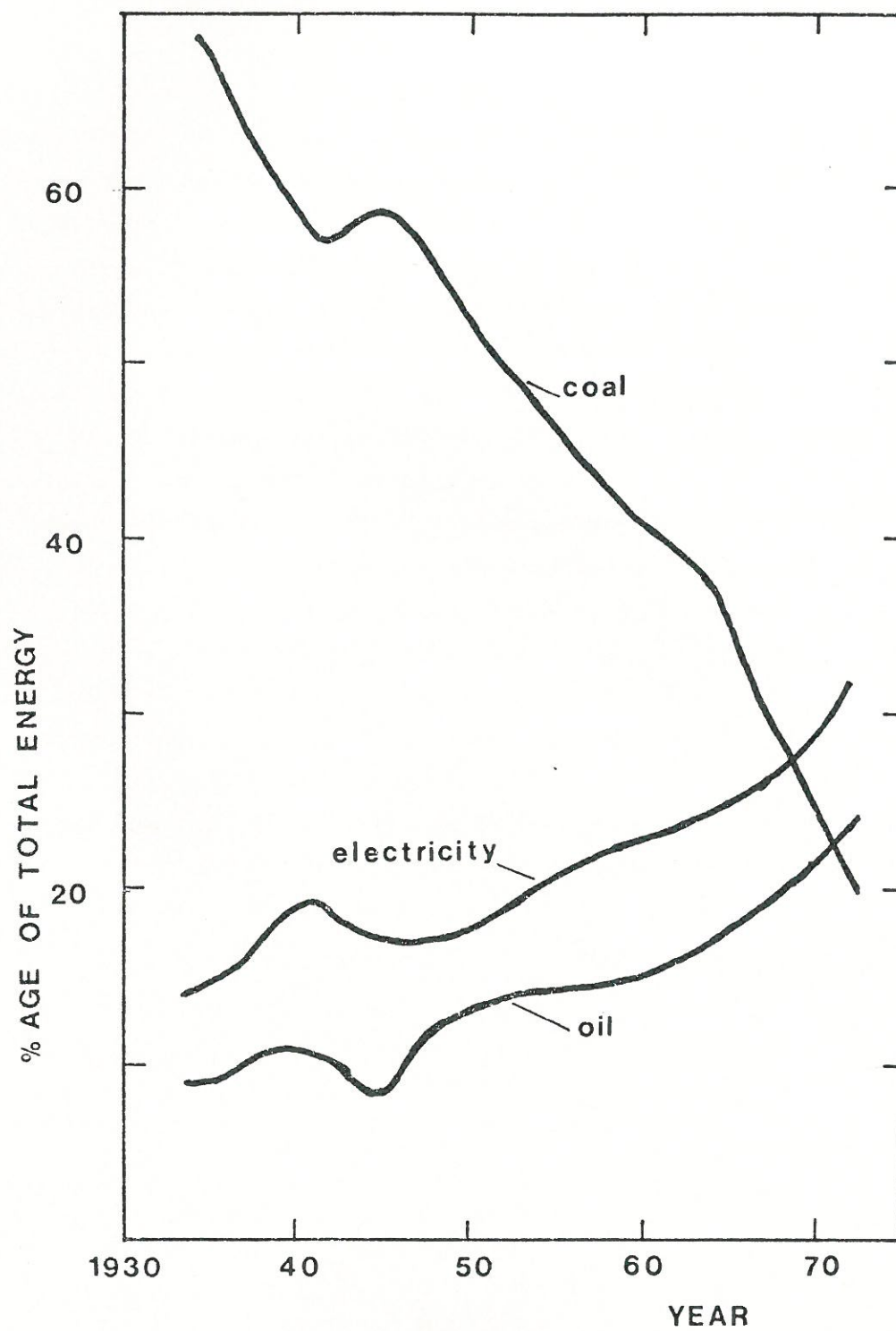


FIGURE 1

COAL, ELECTRICITY, AND OIL CONSUMPTION

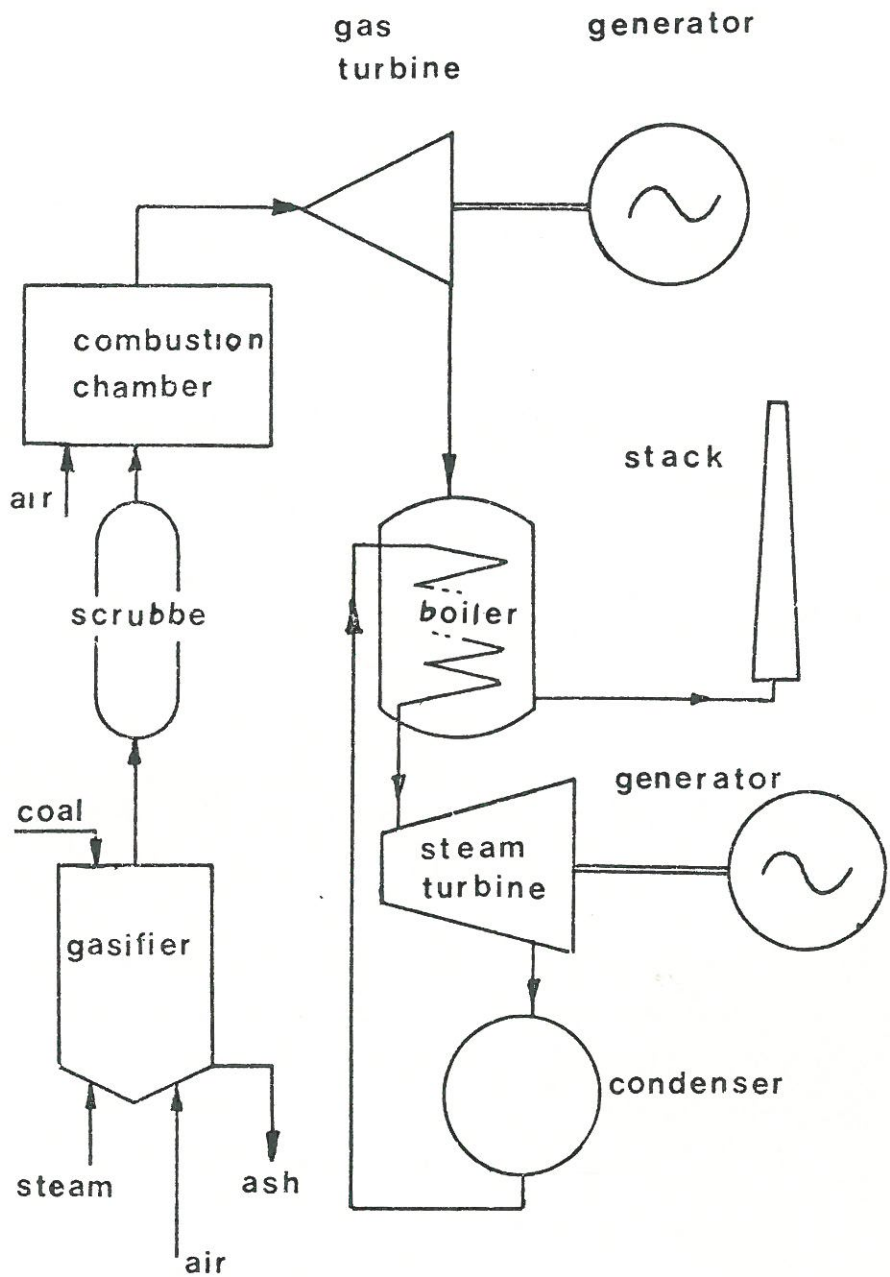


FIGURE 2

DUAL-CYCLE POWER PLANT