AIR POLLUTION DISCUSSED IN RHODESIA

The Rhodesian Society of Occupational Health held a series of meetings during August, the subject being "Pollution and the Industrialist". Three of our members, Mr. K.R. Johnson, Mr. N. Boegman and Dr. J.D. Louw spoke at these meetings and we print their papers below.

SMOKE CONTROL IMPLEMENTATION

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INTRODUCTION

In order to implement smoke control we must understand what smoke is, how it is formed, and how it can be controlled technically and legally. We are all familiar with smoke belching from a chimney. In reality it is a complex mixture of unburnt hydrocarbons, gases, smoke, soot, ash, grit and gritty particles. If we look at the smoke particles under an electron microscope we can see how very fine the material is, consisting as it does of sub-micron particles which have agglomerated together. Some of this material remains in a finely dispersed form and the large surface area accounts for the very high light scattering properties which is why a small amount of smoke finely dispersed can produce a typical haze or smog. It is the ultra fine nature of this material that makes it so difficult to collect in conventional collectors which can easily dispose of the grit and ash problem. These smoke particles are generally formed when the fuel supply to the furnace releases volatile matter which is not completely burnt. Smoke and grit pollution can emanate from the following sources and the action indicated to correct them can be instigated by the industrialist whether legislation for air pollution control exists or not. In reality the laying down of smoke control standards serves as a general target for all industrialists to aim for and this universal type of approach fosters their co-operation.

SMOKE AND GRIT FROM INDUSTRIAL BOILERS AND FURNACES

Handfired boilers and furnaces using coal can emit excessive smoke and grit

unless due regard is taken to the correct method of firing. This should either be side firing, often called wing firing, where alternate sides of the fire bed are covered with a light layer of coal to ensure that there is always one side of the fire available to provide an ignition surface for combustion. A lighter sprinkling of coal over the whole bed may suffice depending on the volatile matter of the coal and the heat of the furnace. The two golden rules are "little and often" and the three TTTs :-

TIME - the smoke and gases must have time to burn.

TEMPERATURE - the temperature must be adequate to ignite the gases.

TURBULENCE - there must be sufficient mixing of the gases with secondary air for combustion.

Alternatively, mechanical stoking can be introduced in the form of underfeed stokers, low ram coking stokers, sprinkler stokers, spreader stokers or chain grate stokers. All of these involve the use of forced draught fans which aggravate the grit problem, particularly with regard to the underfeed stoker where the fuel bed tends to clinker and is difficult to remove through the furnace door. A cut-out switch should be fitted so that the underfeed stoker cannot operate while the furnace door is open.

The grit collectors used on medium sized boilers are generally of the inertial or centrifugal type which allows the grit to fall or be spun out of suspension in either a conventional cyclone or a multi-cyclone consisting of a battery of small cyclones. Only very large installations, generally Power Station Boilers fired with pulverised coal, use the very expensive electrostatic precipitators.

Prior to the increase in price of oil fuel this could be strongly recommended to industry for the elimination of smoke and grit but caution should be exercised in view of the dramatic price increases.

The oil burners used are generally of the fully automatic type controlled by pressurestats with automatic purging cycles, ignition fail safe alarms, etc. They are generally of the pressure jet or the rotary cup type. In the pressure jet type the oil is ejected through an atomising head into a swirling air mass while in the rotary cup the oil is fed into a rapidly

revolving hollow cup and spins off at the periphery into the turbulent air mass for complete atomisation. Rotary cup burners are generally used with heavy furnace oil which requires preheating according to the supplier's recommendations. If the correct temperature is not obtained by the pre-heater poor atomisation and smoke emission will result. Cenospheres may also be formed; these are virtually hollow coked oil droplets which, being light, are difficult to settle out in conventional collection equipment. They are best eliminated by commissioning the burner to ensure the correct air fuel ratio, correct preheat temperature and sufficient heat and turbulence in the furnace to ensure complete combustion.

SMOKE FROM HOT WATER AND COOKING STOVES

The majority of the solid fuel fired hot water stoves are generally designed for low volatile or semi-bituminous fuels and provided these are used there should be little smoke emission. The main trouble generally found is that the appliances have been neglected and any air pollution control organisation should first examine the appliances and see that they are properly repaired before any demonstrations are given. In this respect it is useful to have trained Non-European stoker demonstrators on the staff who can spend some considerable time with the Non-Europeans who are invariably operating these appliances and see that they understand the basic principles of combustion and smoke control. One of the inevitable bonuses of this demonstration is that the people concerned get more hot water for less fuel and expense. Some hot water stoves are large enough to be fired with underfeed stokers but this can give rise to grit emission and a better proposition is either oil firing or replacement by the Zeta boiler which involves the hopper feed principle again. Hotel cooking stoves are often hopper fired and the gradual feeding in of the coal eliminates overloading of the fire and smoke emission. With the smaller old fashioned stoves firing little and often and the use of semi-bituminous coals is the only safeguard but a number of cocking stoves based on a hopper feed principle in the small range are now available and give little or no smoke emission. When building new Non-European Housing Schemes consideration should be given to installing stoves of this type or granting subsidies to persons prepared to buy recommended smokeless stoves.

Whether air pollution legislation be introduced or not smoke complaints will be received in built up areas and some official will have to investigate and attempt to rectify the problem once the smoke or grit nuisance has been established either by investigation, observation or measurement. The inspectors should first of all negotiate with the firm concerned to rectify the matter, supporting his representations by the results of observations, samples of grit, etc., and he must then be able to advise on technical aspects, showing the firm what can be done to eliminate the problem. The training of Inspectors in a country which is just embarking on air pollution control obviously imposes severe problems but several countries now operate correspondence courses on air pollution control which are designed to educate Inspectors, in theory at least, to a reasonable level. This can often be backed up by visits to other countries where a period of training can be spent with an Inspectorate. This can then extend from one enlightened centre in a country to another and this is the normal type of air pollution control development. One of the best courses to date is run by the External Studies Department of the Witwatersrand College for Advanced Technical Education and an increasing number of air pollution Inspectors in South Africa are taking this course. Another avenue for general education in the whole field of air pollution control is by the establishment of assocations such as the National Association for Clean Air, which is very active in South Africa, which provides a forum for discussion and regular meetings at which air pollution and its control can be discussed and ideas exchanged, questions asked, visits arranged, etc.

The syllabus of the Witwatersrand College for Advanced Technical Education correspondence course on Combustion Principles and Practice referred to above is listed below.

1. Solid fuels.
2. Liquid & gaseous fuels.
3. Composition & analysis of fuels.
4. Chemistry of combustion.
5. Combustion air.
6. Heat transmission.
7. Steam generation.
8. Steam & heating boilers.
9. Methods of firing coal & liquid fuels.
10. Draught.
11. Boiler auxiliaries.
12. Boiler house instruments.
13. Feed water.
14. Boiler efficiency.
15. Steam utilisation.
16. Boiler house organisation.
17. Smoke & smoke control.
18. Legislation.
19. Practical visits, etc.

COAL FIRED LOCOMOTIVES

Locomotive smoke can be controlled by the judicious use of the steam injector which is used to create chimney draught when a locomotive is standing and by opening the fire door slightly to allow the ingress of secondary air necessary for combustion of the volatile matter which is released rapidly from the coal when it enters the hot furnace. The difficulty in semi-tropical climates is that when you open the fire door on the locomotive platform the heat radiating out can be excessive and there may be merit in fitting a chain curtain in front of the door to screen the footplate men from the radiant heat. Certain locomotives can be mechanically fired and this certainly makes it more easier for smoke control. It is generally a rule on all railway services that excessive smoke is a contravention of their own regulations. Much can be achieved by the railways appointing their own smoke inspector, preferably a man with loco driving experience, who can talk to the locomotive drivers in their own language and foster their support. One of the schemes we use in Durban is to obtain, via the railways own smoke inspector, the names of drivers and firemen on locos observed emitting excessive smoke. The list of offenders is posted up in each railway depot every month where it is hoped that the offenders will see themselves blacklisted and their colleagues will rag them about it. Blatant offenders are fined by the Railway authorities.

DIESEL SMOKE CONTROL

Vehicle fumes can be a problem particularly that from diesel engine vehicles which are often observed emitting dense black clouds of smoke to the annoyance and danger of other road users and pedestrians. Obviously such emissions at ground level must be controlled and experience has shown that it is wise to establish a limit based on a recognised method of measuring exhaust smoke and to implement this with the aid of Police Officers, Traffic Officers and Air Pollution Inspectors. Anything short of this is not likely to have very much effect. There are various meters commercially available these days for measuring smoke from exhausts and the two best known are the Hartridge Smoke Meter, based on the smoke obscuring the light which falls on a photo electric cell and the Bosch Smoke Meter which samples 300 ml of the exhaust through a filter paper disc. This leaves a stain which can then be measured

by a photo electric cell and a light source placed over it. While most organisations seem to have opted for the former type of meter as a basis for the legislation the author is of the opinion that the Bosch Smoke Meter has considerable merit insofar that it is cheaper, simpler, easy to operate and provides a permanent record which can be used in any subsequent prosecution or negotiation with the owner of the vehicle. The Hartridge Smoke Meter on the other hand is a more complex instrument prone to upsets, particularly with the rugged handling encountered in the joint road patrols and it certainly needs careful maintenance to keep it operable. In practice vehicles exceeding the prescribed limit are suspended and their Certificate of Road Worthiness is withdrawn and they can only regain this by satisfying the authorities at the vehicle testing grounds that their vehicle can comply.

One danger here is that people can replace fuel injectors and fuel pumps with properly serviced items and once they have passed the test these new top quality items can be removed and kept ready for the next vehicle. While this sounds crazy it does in fact happen on occasions and the inspectors clearing vehicles have to be wide awake in this regard. Another dodge is to reduce the fuel injection rate when the vehicle is submitted for testing and then open it up on the fuel pump rack once clearance has been obtained. Again the inspector must be on the ball and see that the fuel pump is properly set and sealed so that it cannot be tampered with and that the vehicle as tested has adequate power before clearance is given.

INCINERATORS

The vast majority of people disposing of refuse want it done for nothing and any expenditure on incinerators is generally seriously frowned on. The authorities must ensure that only certain industries can install incinerators but these must be approved by having oil fired main burners and after burners to eliminate the smoke with a grit collector of the inertial or centrifugal type if warranted. It must be emphasised that the incineration of waste materials is a far more difficult problem than the combustion of a fairly regular grade of fuel. Authorities should be careful not to allow incinerators in residential or business areas or for the disposal of garden refuse which should be removed by the usual Cleansing Service.

IMPLEMENTATION

Having reviewed very briefly the technical aspects of the problems I meet the question "How does one implement smoke control?". The first essential is to win the support of the people who you wish to control and this is best done by establishing a joint committee representing all concerned; Chamber of Industries, Local Authorities, Government, Health Authorities, Commerce, Hotels, Laundries, Dry Cleaners, etc., and establishing a Cleaner Air Campaign within which all aspects of air pollution control can find their rightful place. The next step is to appoint properly qualified people to undertake this work and it must be emphasised that, in the foregoing, I have glanced very briefly over what in some cases can become very involved technical problems where the guidance of experts in the field of combustion or dust collection are required. The trained staff must then spread the gospel by organising courses, meetings, visits, demonstrations, etc., and they must first of all gain their spurs by showing people that they do in fact know what they are talking about. Once people start to accept them they will find the going much easier. Legislation will of course help but it must be reasonable legislation and it must be fairly implemented and it should give the industrialists time to adjust themselves to new changes, new expenditure, new concepts, new plant and in some cases even new staff.

Most legislation embodies a smoke limit and this is generally based on an acceptable smoke standard which in turn generally originated from the Ringelmann smoke standard. To avoid confusion this can be explained simply as light smoke, dark smoke and black smoke which is the sort of language that anybody can understand. If you call these shade 1, 2 and 3 the normal requirement is that no chimney should emit smoke darker than dark smoke or shade 2 for more than three minutes in any period of half an hour.

To ensure that industrialists know exactly what their plants are doing the Department computes all the smoke observations every month-end into an order of merit table which is sent out to all the firms concerned. They can then see not only how they fared but also how they compared with other firms. This creates an interesting incentive scheme and at the end of the year Certificates of Merit are awarded to those firms who have virtually made no

smoke throughout the year, which is a very commendable achievement. Many firms use this smoke report from the Department as the basis of a bonus scheme for the operators of their boiler plant so that, when no smoke is produced for a month, the operators receive a bonus. This scheme also enables one to compare variations in smoke emission over the years and the table shows how the smoke points against the first group of firms monitored have been reduced from 1957 to 1975

1ST GROUP MONITORED	MONTHLY SMOKE POINTS AGAINST FIRM	
NAME OF FIRM	MARCH, 1957	MAY, 1975
KING EDWARD VIII HOSPITAL	172	0
O.T.H. BEIER & CO., LIMITED	131	0
DELL SOAPS (PTY.) LIMITED	92	0
S.A. BREWERIES	85	0
K.S.M. & CO.	80	0
BAILES (PTY.) LIMITED	79	1
FAVOURITE STEAM LAUNDRY	73	0
ELECTRICITY SUPPLY COMMISSION	55	14
MARACHIA STEAM LAUNDRY	41	0
LEVER BROTHERS S.A. LIMITED	33	0
HOLDAIN BOXES LIMITED	33	0
SUNCRUSH LIMITED	32	0
ABATTOIR	32	0
TYRESOLES	28	0

After all, the authorities cannot be watching all the chimneys all the time and one relies on the firms themselves to do the necessary controlling. Perhaps the biggest innovation in the regulations is the requirement of prior approval of all fuel appliances by the responsible party. This means that they do not have to stand by and watch inefficient, unsuitable appliances being installed which will only add to their problem and they can ensure that only smoke free equipment is installed which in itself will go a long way to resolving the smoke emission one sees today. Another facet of the legislation is the establishment of smoke control zones or even smokeless zones whereby in certain areas, such as residential areas, very stringent smoke limits are laid down and again these must be borne in mind when applications are made to install appliances in these areas.

CONCLUSION

Results have shown that Clean Air Campaigns can be won. To those embarking on such campaigns I wish every success.