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PUMPS AND PUMPING: WHAT THE INDUSTRY WANTS FROM PUMP MANUFACTURERS(*)

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INTRODUCTION

It is my privilege to present the second paper to the Symposium, which is to discuss a topic of considerable concern to the Nottinghamshire Area of the British Coal Corporation. Whilst appreciating that other aspects of water control will be presented, and the contributors from outside the mining industry will participate in the Symposium., it must be from within the coal industry that my comments are made.

The Coal Mining Industry uses pumps for many purposes. The most obvious use that concern a Mining Engineer, is that of minewater control and pumping to the surface. Pumps are also used to maintain the environment and operate our production machinery. For example, the chilled water system now installed at Harworth, requires circulating pumps for various functions, many km's of lagged pipe carry the chilled water to the working places, complex control and monitoring systems control the operation. Colliery surfaces have pressurised fire fighting mains which reach into the Coal Preparation Plants and Bunkers.

The modern coal preparation facility is a veritable maze of multiple pumping and water control situations.

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Various fluids, ranging from "clean" water to heavy tailings, are pumped from rivers and boreholes to the tower and settling cone; over the tip to the lagoon - and back again. Some times the distances are considerable. Boiler plant, Water Treatment Plants, domestic water systems and Bathing facilities all require pumps of various pumps types and sizes.

Almost every power loader, powered support system, large gearbox, locomotive, roadheader, free steered vehicle and bucket loader relies on to pump to provide hydraulic power or lubrication using other fluids such as mineral oils and non flammable liquids.

From this it can be seen that the Mining Industry is a major user of many types of pumps. The pump is very often taken for granted and passed by unnoticed until some malfunction results in a disruption to normal workings. This can be a cessation in coal production, if a main swashplate pump fails on a trepanner, or water lapping over boot tops, when a mono pump stator runs dry and burns out. It is then that the importance of reliability becomes obvious.

The objective to make pumps in the Mining industry even more anonymous, by improving their reliability and reducing their for costly and irritating maintenance.

MINEWATER PUMPING

It is estimated that over 30 % of rainfall percolates through the strata via porous rocks, permeable formations, cracks, fissures or old workings in mining areas. The various water retaining beds are often encountered initially during shaft sinking operations. Depending on the make of water , this can either be pumped, or controlled by ground freezing or grouting methods. In either case, it is highly desirable to seal the finished shaft wall to maintain as dry an atmosphere as possible, for the benefit of the winding, signalling and power supply apparatus. This is not always possible and controlled water collection by garlands and piping can divert the water to a suitable sump. In general, in the Northern part of the Nottinghamshire Area excessive water directly associated with the mining operation has not been a problem. It is the older workings in the west of the Coalfield, generally in the Southerly part of the Area, which have suffered and will continue to suffer from excessive minewater. Many collieries both working and abandoned on the Western flank of the Area are 'wet" and have relatively shallow workings and have been connected

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underground for a variety of reasons, many barriers between old private undertakens have been breached or were inadequate and several pumping installations discontinued, combining to create increase pumping needs at existing collieries.

As the area has become more and more intensively mined at ever deeper levels, a vast network of tunnels has been created through which water can permeate. This has created problem at Annesley/Bentinck Collieries, which one of my colleagues has discussed in a previous paper. It is certainly not as bad as the vast underground lake in the area of Pittsburg, which has been investigated at length. This was caused by very intensive anthracite workings using pillar and stall methods, which effectively created huge areas of void which when mining ceased in the 1960's, literally filled with water. The effects of natural water tables, sources of potable water and surface flooding patterns are still being investigated.

This bring us face to face with the main problem with minewater. it is normally so polluted and contaminated that it would be best for all of us if it could be controlled underground by dams and not brought to the surface at all. When it is brought to the surface it cannot be freely discharges into adjacent water courses. Considerable expenses often incurred in chemical treatment , settling ponds, weirs filters baffles, before tolerable levels of impurity can be discharged into the local water courses. Levels of chemical and physical cleanliness are constantly being elevated and imposed on the "producers" of such minewater. It is these very contaminant which foreshorten pump and pumpline lives, incur heavy maintenance costs, occasionally result in breakdowns and very occasionally, I must add, invoke the more serious possibilities of uncontrolled flooding.

Both basic types of pumps, namely volumetric displacement and Kinetic energy, are used to pump the minewater. The volumetric displacement pump is used normally for relatively small amounts of water but pumped at a high pressure. The common ones encountered are three-throw ram pumps and mono pumps. Both require maintenance if only because they tend to handle minewater containing suspended solids. This damages valves and seats and scores stators. The "nuisance" quantities of water will always exist a relatively maintenance free, light weight water pump is essential. Many coal face maintenance tasks have been abruptly halted by cry, 'Stators burnt out!" usually because air is being drawn into the pump. Perhaps a pump is available which

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will automatically switch off, or disengage its electric drive if water flow ceases and the sucking of air causes a temperature rise.

The Kinetic energy type is normally used for larger volumes of water at lower heads and hence the single stage centrifugal pump is not normally a minewater device. But its larger brother, the multi stage centrifugal or turbine pump is in common use in shaft bottom schemes and larger inbye dewatering stations. The turbine submersible pump is of this family. The turbine pump is, however, does not work too well on the suspended solids often found in minewater and hence settling tanks, with all manner of baffles and weirs, are used. The disposal of the resulting sludge often proves difficult, but it is the iron based ochres and heavy salted waters which cause breakdown of many pumps. Despite the use of non-ferrous components and advanced design of impellers and diffuser chambers etc., the annual toil of lifting large submersibles out of 400 metre deep shafts continues. The need to have standby capacities always at the forefront of Mechanical Engineers' minds. The little tricks of priming pumps, which may be a considerable distance from a normal working place, often add grey hairs to the head of automation designer. What is needed is a turbine pump, which will always start and never fail, because very often the unforeseen failure to pump large quantities of water at some inbye location can be inconvenient to say the least. Perhaps there are very hard, structurally sound, chemically inert plastic compounds which would ease the problems of impeller and diffuser wear; and internal pipeline coatings which resist deposition of ochre.

Automated pump systems, for inbye locations as well as shaft bottoms, having considerably reduced maintenance costs and the minimum of standbye facilities must be the order of the day. In these circumstances long tem reliability is vital.

The operation and starting of a pump at some isolated location must be guaranteed on every occasion by the use of Intrinsically Safe and Flame proof motorised valves. Most inbye stations do not lend themselves to the use of submersible type pumps either vertically or multi-stage centrifugal pumps need updating to ensure that the suction is always flooded.

Because inbye pumping is controlled by water level switches to create pumping bands, the sizing of the pumps is often a compromise based on the economics of electricity tariffs, the make of water and the capacity of the receiving system. These pumps

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often deal with variable makes of water and more investigation is required into variable delivery pumps capable of matching water discharge with infeed over a reasonably wide range. A variable volume pump would seem to have an economic advantage if only operating at the power level necessary to discharge the make of water and possibly needing smaller catchment lodges, This is a field where using field couplings as the source of variable speed and hence variable capacity could warrant a fresh approach.

HYDRAULIC POWER PUMPS

Although not within the strict remit of water pumping, these pumps are a vital part of all powered support systems and operate on 95/5 water soluble oil fluids. Pump design of of all types whether fixed or variable displacement have to be fitted into physically small locations, run consistently at high speed and pressures and on less than ideal non-flammable fluids. These relatively small but essential components should be made of the highest quality materials. Often it would seem that ease of replacement is more important than longevity of reliability. Replacement and maintenance is a costly non-productive exercise which should be minimised by design. The downtime caused by pump failure is considerable.

The use of non-flammable fluids will become even common including their use in power loaders. Pump, valve and filter design must advance to cater for the differing hydraulic and lubrication qualities of these fluids.

COAL PREPARATION PUMPS

The plant requires clean water from a borehole, and adjacent watercource or a storage tank for the washing process. The single stage centrifuge is normally quite satisfactory in the surface situation and generally gives little trouble. The multi-stage turbine works well when pumping clean water from a borehole. The centrifuge pump of the kinetic energy family normally requires priming and to have guarantied a fully flooded suction before the delivery valve can be fully opened. This is often a manual operation; here again there is scope for mechanisation. The vast array of valvework on a petro-chemical refinery surely has a large element of automatic operation from which we can learn. The reduction of destructive cavitation by a controlled monitored valve system would be of value in extending pump

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lives.

It is not only clean water which is circulated, in the coal Preparation Plant much of the liquid is in fact a suspension of coal or dirt in water depending on the pump's location in the process. These are the circumstances for which more exotic materials have been developed for pump components, bodies, sealing arrangements, valves and pipework. Sophisticated reins have been developed for rapid repairs and revolutionary pipelinings are on the market place, but still the price of maintenance is too high.

Where the percentage of suspended solids results in a slurry being pumped then the impeller needs to be particularly resistant to abrasion, corrosion or shock loading, Fore some time rubber coating has been one of the answers to this problem. It is, however, still necessary to change such components as impellers and volute liners too frequently.

CONCLUSIONS

It is not my remit to pore over pump characteristics curves, or to detail impeller vane design to reduce losses and cavitation, but to impress on the manufactures the urgent need for improved ease of operation, enhanced component lives and dramatic reduction in maintenance requirements. I am sure that I am asking the very questions which have always encouraged advancement in pump and pipework design. There are certainly the needs of todays Mining Industry with the ever increasing need to reduce the total cost.

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