ROTARY MILL LINER PRACTICE IN THE SOUTH AFRICAN GOLD MINING INDUSTRY

By J. H. French and O. E. Lissner

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Written contribution

S. J. Venning (Member): The authors should be congratulated on producing such concise data from the plethora of experimental report results.

Their observations on the cost of liners calls for some comment however, as the really unique feature about liners in South Africa is that they can be obtained so cheaply. Attention has been focussed on the 1961 cost of white iron at R50 per ton for chill cast block liners while manganese steel liners are reported as costing as much as R250 per ton. The former are however, a relatively heavy, simple casting with a low labour content and reasonably high percentage productivity, made from metal melted in a cupola. The capital investment to produce this type of casting is low compared with that required to produce manganese or other alloy steels. The chill cast liner block is always a production item and is cast in a permanent mould. Almost all manganese mill liners, except perhaps small aperture screens, are sold for considerably less than the R250 per ton quoted by the authors. Where a price of this nature is asked it would be because the design of the casting demanded is complicated or leaves little metal to carry the labour and other costs of production. As reference has also been made in the paper to liner costs in America, prices for similar types of liners obtained during a visit to Canada and the U.S.A. in 1961, could be of interest:

	Material	Price per short ton	Location
Body liners block type	Ni-hard	R250	Elliot Lake
	Ni-Hard	R300-310	FAS New York
	Mn Steel	R280-290	FAS New York
Screens (grids) slotted hole	Cr.Mo. Steel	R600	FAS New York
	Ni-Hard	R320	Elliot Lake

At this time the price of comparable manganese steel block type liners on the Witwatersrand was between R145/R155 per short ton. White iron in Canada was then quoted at about R150 per ton, but as Ni-Hard gave a life of at least two to two-and-a-half times that of white iron, it was a much more attractive proposition particularly when relining and down time costs were taken into consideration.

There is little doubt that most foundries would welcome clear and complete specifications of the customers requirements and systematic checks to ensure that these specifications are being met. B.S.S. or other accepted standards should form the basis of these, and periodic inspections should be undertaken to ensure that only those foundries capable of complying should be included as suppliers.

The authors have referred to new designs, but can the industry really call the grid and plate new when the patents were taken out during the second world war and the sawtooth block has been used for at least 35 years. Unfortunately, far too little thought and consideration are normally given to the ultimate mill liner design while the mills themselves are on the drawing boards. The position and size of the door opening, which is the key to the ultimate shell liner configuration, the drilling of the

shell and ends, often are decided and effected long before any real thought is given to the liner layout and design which then has to be tied to unnecessary complications, viz.: specials and odd blocks, which could have been avoided had the procedure been reversed. It is only from a start at this point that any degree of real standardization could be achieved. Major variations in items such as position and size of door openings and trunnion diameters in mills of the same size and type on the same mine are not unknown. There is little standardization, even in the type and size of bolt heads used for similar duties, amongst the various mines of a group, much less amongst the groups themselves, and evidence of the discard of liners before full value has been achieved can on occasions be traced to the design and positioning of the bolts.

Little if any consideration is given to foundry problems when the design of liners and bolt holes is under review, and this has led to complaints about casting solidarity, cracking and other imperfections which in turn increase liner costs. Closer co-operation, with actual visits by users to foundries producing their liners, could lead to a better understanding and appreciation of the problems.

At the very start of the paper under review, reference was made to rationalizing with a view to reducing operating costs; it is the humble opinion of this contributor that while there is little evidence of standardization in the industry, too little attention has been given to liner design, particularly profiling to counter heavy wear areas, and the method of dividing up the liners so as to produce a minimum of discard metal. Liner scrap has revealed variations of from 15 per cent to 70 per cent discard metal. While the former is exceptionally good, not more than 30-35 per cent discard metal should be regularly attainable if consideration were given to these points, together with the design of bolt heads which would enable the liners to be worn reasonably thin. An increase of over 200 per cent in the life of the shell liners in rod mills was achieved on one of the taconite mines in Minnesota, U.S.A., by attacking this problem systematically over a period of 3-4 years.

First cost and not the ultimate overall cost appears to be the most important consideration in many purchases made for the mining industry. This may be due to the fact that the buyer, who is remote from the point of use and more often than not because of his remoteness has little user knowledge of the commodity being bought, or its application, is seldom if ever held accountable for his decisions, be they good or bad. This policy must to a degree remove the initiative from the men on the spot to undertake improvements and experiment with different alloys, designs, etc., thus the investigation which has been undertaken through the Chamber of Mines with the blessing and support of the mining groups is all the more commendable.

There is ample scope still for savings to be effected in liner costs in terms of cost per ton milled by an intelligent approach to the wear profile of liners to ensure that the minimum of metal is ultimately discarded, and that slip which is probably the greatest wear factor in any mill is kept to a minimum for as long as possible.

Being connected with the foundry industry, we would like to add our thanks to the authors for their patience and consideration during the preliminary investigations and production stages. It is to our regret that Mr French has now retired, and that Dr Lissner died before this work was completed. Their interest in and understanding of our problems, coupled with their enthusiasm throughout this investigation were highlights in what could have become a drab operation.

Authors' Reply

J. H. French (Author): The reception accorded to this paper has not only been

most pleasing, but would have delighted the heart of my late colleague, and thanks must be offered to those who made such constructive comments. These brought forth a quantity of new ideas and data, so that it becomes difficult to reply.

Mr J. H. Mortimer's brief outline of liner history forms a useful addition to other information. I recently had the opportunity of talking with one of the few old stagers left, who had actually installed flint block liners in the 'good old days', and what a job it must have been. With Mr Mortimer's championing of the Osborn Bar type of liner one could not agree more. This liner, apparently little used outside of South Africa, still deserves attention and further experimentation is desirable to enable it to be adapted to larger diameter mills, where adequate securance is required to avoid liner collapse. In this consideration should be given to correct taper on the bars, so that contact and wedging are perfect between radial and spacer. The diagrams below are purposely exaggerated (Fig. 1), but should show how a bar with taper suitable for a small diameter mill would give imperfect wedging if applied to a large diameter mill.

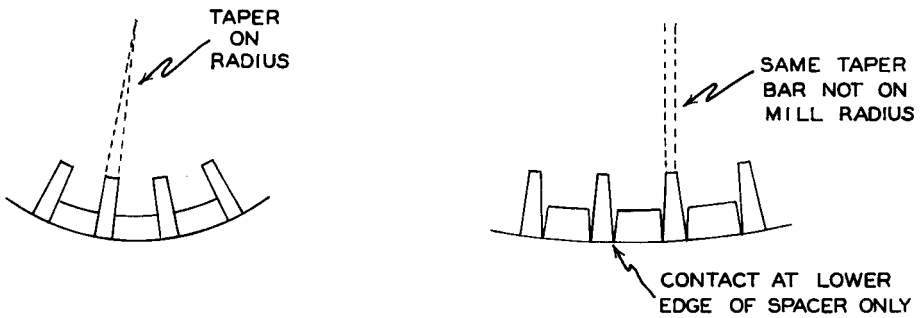

Fig. 1

Another suggestion to improve securance is some locking feature rolled into the bars and spacers as illustrated. (Fig. 2)

Fig. 2

Mr Mortimer's quoted figures on the life of liners in relation to mill speeds, capacity and power consumption show excellent attention to mill economics, and

mines may find it advisable to examine their own installations and milling conditions in the light of these revealing data.

Dr J. M. Bereza's point on the widest possible dissemination of the newly gained information is appreciated. Not only is dissemination of information desirable, but report back on new developments equally important, since liner experiments are necessarily long term projects, and often original tests work, which triggered off new lines of thought may be lost.

The point made that hardness is not always the sole desirable criterion in alloys for tube mill liners is well exemplified in Alloy 4, where good wearing qualities were shown with even a comparatively low hardness. At this juncture I feel it only fair to break through Dr Bereza's curtain of modesty and congratulate him and his colleagues on the development of this alloy.

Mr P. E. Franzl's call for stricter control in manufacture cannot be amplified enough. Until realisation of this need has soaked into the systems of makers, mine buying departments and mill operators, improvement in certain operational results will not be effected. We cannot urge too strongly the establishment of standards for materials employed.

In answer to Mr A. H. Mokken's comment, one has to admit that as far as achieving an objective was concerned, no spectacular results were obtained. Rather did we feel that we had called attention to the need of a general reassessment of liner use, for more thought and investigation, the abandonment of a certain complacency, and the discard of old rule-of-thumb methods. Data collected and certain test results do show that certain alloys have not always been wisely applied in the past. At the same time departure from other well tried out alloys is not advised in favour of certain high cost, complex alloys or substitutes often put forward under conditions of high pressure salesmanship.

His remarks on the full utilization of installed mill capacity, and the relation of this to suitable liner design to obtain maximum grinding efficiency, link up with Mr Mortimer's trend of thought regarding liner wear and mill speeds. These aspects should provide a field for future investigation, together with the all important matter of the relation of power consumed to grinding effected as stressed by Dr O. A. E. Jackson. Herein too is coupled Mr E. J. Dominy's plea on more attention to liner design.

While it was originally intended to include grinding media in the investigation, it was felt, after preliminary examinations, that little improvement could be suggested over locally produced cast steel balls, which economically could compete successfully on export to far away places, with costly forged alloy steel balls, produced in Europe and America. This was backed by personal experience of one of the authors, through field tests. Nevertheless, in a short examination of rod steel used, we did agree with Mr H. Britten's point, that the mining industry should call for rod steel made to its own specification, and not be merely content with a grade of steel available from suppliers.

At the time of the investigation we could not express all the views we held, without fear of treading on corns, but now in the bliss of retirement I cannot but support some of the straight from the shoulder hits Mr Venning makes. Telling points he sets out relate to:

1. Mill liner design.
2. Positioning of door openings.

3. Drilling of shell ends without relation to liners to be installed subsequently.
4. Elimination of "specials" and odd size liners.
5. Foundry problems in relation to design and bolt hole positioning.

Liner users would do well to take up further his line of thought and act firmly. Too long has the field of liner design been a Tom Tiddler's ground for all and sundry, from buyer, through engineer to reduction officer to play in, and his line of thought clearly indicates that the time is ripe for specialist work. While we drew largely on years of experience in our several fields of work, perhaps now study should re-commence right from the basic fundamentals of milling knowledge, forgetting what has gone before and developing from first principles. In so doing such important features as optimum liner design in relation to mill speed, establishment of strict alloy specifications, organisation of a rigid inspection scheme of liners prior to use or acceptance, and standardization of sizes and shapes etc. might possibly be resolved for once and for all.

Finally I feel that all those who offered comment will agree that we have far from reached the end of the road. Having laid down my own ox goad I can only hope that another will take it up and be sufficiently dedicated and use it ruthlessly, for no harder task can be found than that of rousing some folk to a state of enthusiasm on something they may regard as a dull subject.

Throughout this reply I have often used the plural 'we' in expressing opinions with which I believe the late Dr Lissner would have concurred. In conclusion I can but pay my own small tribute to his sterling work. After our first meeting, his rapid adaption to my side of the job, which was new country to him, and the way in which he brushed up my many years rusty physical metallurgy were truly remarkable. One could not have possibly wished for a happier collaboration and on his death I lost not only a respected colleague, but also a very fine personal friend. If his tragic end was just like so many of those metal breakages that he investigated, a fatigue fracture, I am sure that he will emerge from the melting pot of eternity as pure refined metal. Vale, Otto.

NOTICE

TECHNICAL CONFERENCE ON TIN

The Department of Mineral Resources of Thailand is organising, on behalf of the Government of Thailand and the International Tin Council, the Second Technical Conference on Tin. The Conference will be held at Sala Santitham, Bangkok from 18th to 22nd November, 1969. Papers will be grouped under three main headings:

(i) Geology and prospecting;
(ii) Mining and ore dressing;
(iii) Miscellaneous, e.g. stimulating production, metallurgy, estimation of reserves etc.

Pre-prints of papers will be circulated. A field trip to Southern Thailand has been arranged for 25th November to 2nd December, 1969.

Details of the Conference and the field trip can be obtained from Mr. W. Fox, International Tin Council, Haymarket House, 28 Haymarket, London, S.W.1, England.