

# The Role of Mixing Methods and Mixer Designs in the field of Iron Ore Sintering

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**D**URING the last twenty years it has increasingly been realised that the sintering plants, far from being just a necessary evil, are in fact an essential part of the metallurgical installations of a blast furnace plant capable of contributing to considerable improvements of furnace operation as well as sizeable reduction of the costs involved in the manufacture of pig-iron.

This development proceeds from the agglomeration of the flue dust and other waste material in an iron and steel plant to the sintering of increasing quantities of fine ores, leading to the production of self-fluxing sinter. This recent development which is today a subject of many discussions was already proposed in its basic concept by Wendeborn<sup>1</sup> more than 20 years ago and put into practice here and there. The burden of a blast furnace operating with self-fluxing sinter consists of coke and sinter only. This has led to a noticeable increase in the number and size of the sinter plants in all industrial countries. This is further augmented by the tendency of most of the works to extend their blast furnace and its auxiliary plants to sometimes a considerable degree in order to raise the production of pig-iron.

The desire to obtain more sinter raised the questions as to how its production and quality could be improved and which factors should be considered when planning new plants for their maximum utilisation.

Next to the reliability and efficiency of the actual sintering machines, which in most cases are of continuous type, the preparation of the sinter mix has a decisive influence on the production and quality of the sinter. One has but little influence on the sintering process when once the mix has been charged and ignited on the sinter machine.

*What actually does the preparation of mix consist of?*

There are three separate processing stages to be distinguished:

- (i) During the actual mixing process the raw materials to be sintered are first intimately commingled which is of great importance for the homogeneity of the sinter, the more

so since in some plants many different, very often 15 and more, kinds of ores are used simultaneously. In this stage it is of the utmost importance that the fuel is distributed as evenly as possible.

- (ii) By adding water to the raw materials which have been commingled aggregates of very small size consisting of the ore and additives and partly kept together by the surface tension of the water should be formed. Depending on the wettability and surface conditions of the raw materials, each mix has an optimum water content for the sintering process which averages between 7 and 14%. This wetting process partly overlaps with and partly follows the mixing process.
- (iii) The third stage to be mentioned is the rerolling or granulating of the material, a process much discussed during the last few years and now employed more frequently. During this stage the aggregates formed by the mixing process are partly enlarged and partly strengthened, in other words, such particles, which, during the mixing process could not be formed into aggregates, will be picked up by them. This process usually results in an increased sinter output due to the improved porosity of the mix. The influence of the mixing processes on different sinter mixes will be dealt with later.

*Which mixing devices are as a rule used in the sintering plants?*

- (i) *Forced mixing units and batch type mixers:* Among these machines the pugmill is well known and frequently used. Other mixers, normally employed in smaller plants, are those developed by Eirich and Raps.

All these devices are excellent mixers, but the forced mixing units are subject to heavy wear and tear caused by the mixing process. Besides, the throughput of these devices is relatively small, especially when compared with the high output of a modern sintering plant. Thus the maximum output of a pugmill is approximately 150 ton/hr. This would mean that in a sintering plant with a sintering machine producing 6,000 tons

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<sup>1</sup> H. Wendeborn—Patent application of the Metallgesellschaft A. G., M. 2904 of 18-1-1938.

sinter per day, requiring about 10,000 tons of raw mix, three such pugmills would have to be operated continuously, in parallel arrangement. Besides, there would have to be provided at least one spare pugmill ready for operation. With such an arrangement it is extremely difficult to distribute the oncoming raw mix evenly over the four units without causing any segregation. The

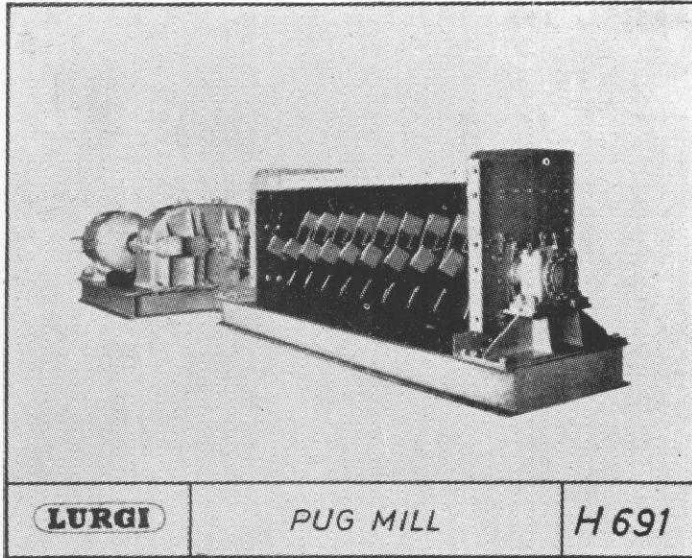


Fig. 1.

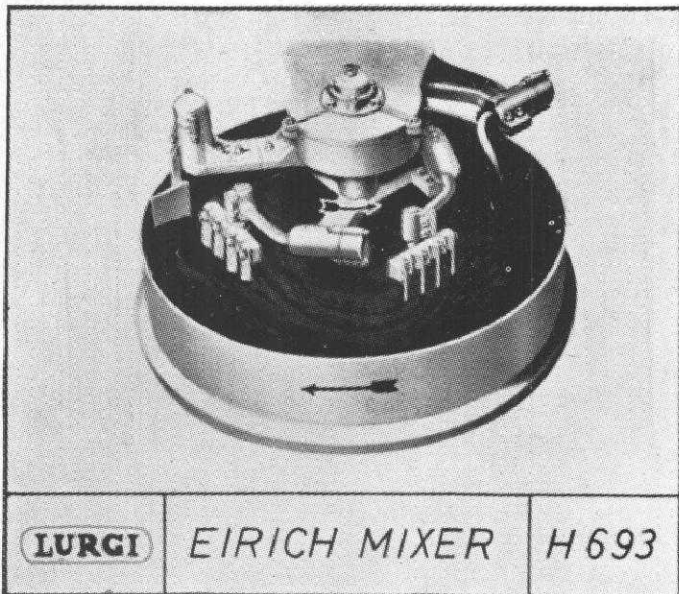


Fig. 2.

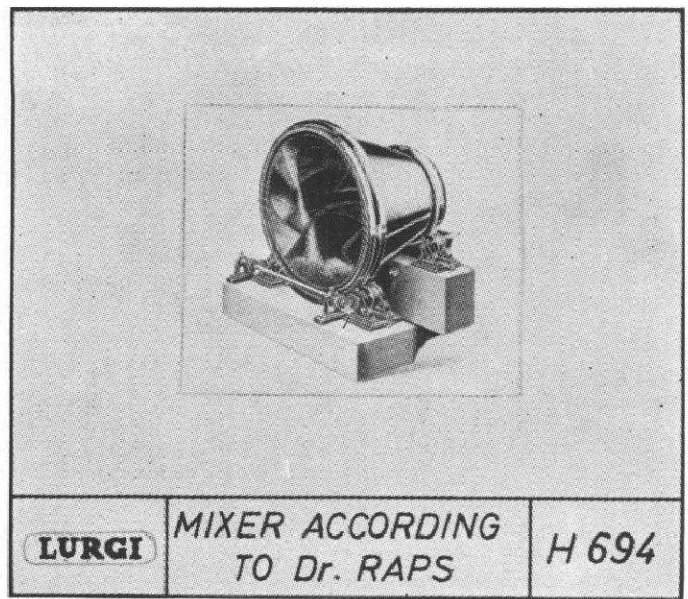


Fig. 3.

- mixers developed by Eirich and Raps mentioned above are suitable only for small plants as they work intermittently.
- (ii) *Mixing drums*: The advantages of the mixing drum lie in its universal adaptability and its reliability.

Fig. 4 shows the outer view of such a mixing drum (type lurgi) which is used both, in conical and cylindrical designs. This difference in the shape of the drums has hardly

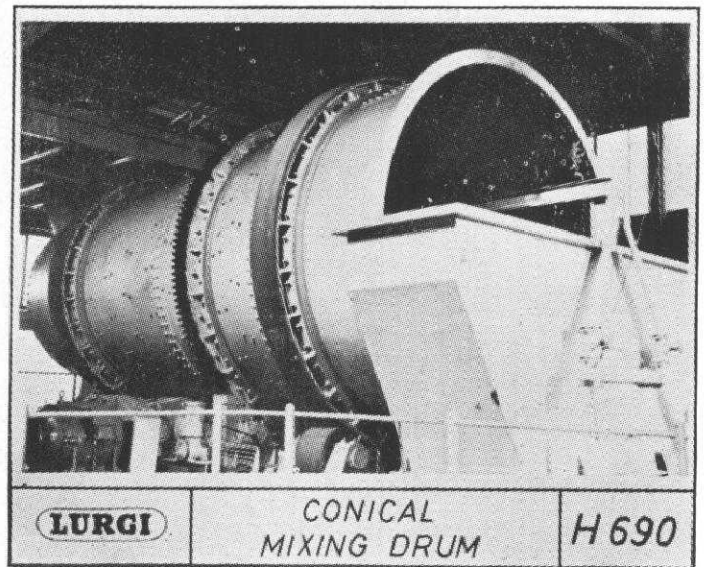


Fig. 4.

any influence on the mixing process, the reason for the difference in design being that in the case of conical drum the central axis lies in a horizontal position. Because of this the tendency of forward travel of the drum shell towards the discharge end is much smaller than in the cylindrical types.

Fig. 5 shows the inside of a mixing drum. The large blades located at the inlet of the drum are designed to convey the material to be mixed quickly away from the inlet, while the actual mixing is done by the large number of blades on the inwall as shown in the figures. Towards the discharge end these drums usually have a short smooth section for the mix to roll. The wetting of the mix which in these drums is carried out by means of spraying jets is not shown in these pictures. The same mixers of cylindrical shape, but without built-in blades, are used as (Fig. 6) rerolling drums.

(iii) *Mixing discs*: A mixing disc as shown in Fig. 7 was first introduced in the cement industry for granulating raw cement meal, whence the use of these mixing units was extended to the pelletising process and some time ago to mixing iron ores in sintering plants. The mixing disc has the advantage that it requires relatively small space and that the mixing process can be observed quite well. But on the other hand it has the great disadvantage that the retention time of the material to be mixed on the disc is limited, and that is why its use

must be restricted to ores requiring only a short mixing time. Another disadvantage lies in its relatively restricted output and here we are confronted again with the same problem of distributing a great quantity of material to be mixed over several units in a large plant. This has already been discussed under (i) in connection with the pugmills. These difficulties were experienced in a plant recently commissioned.

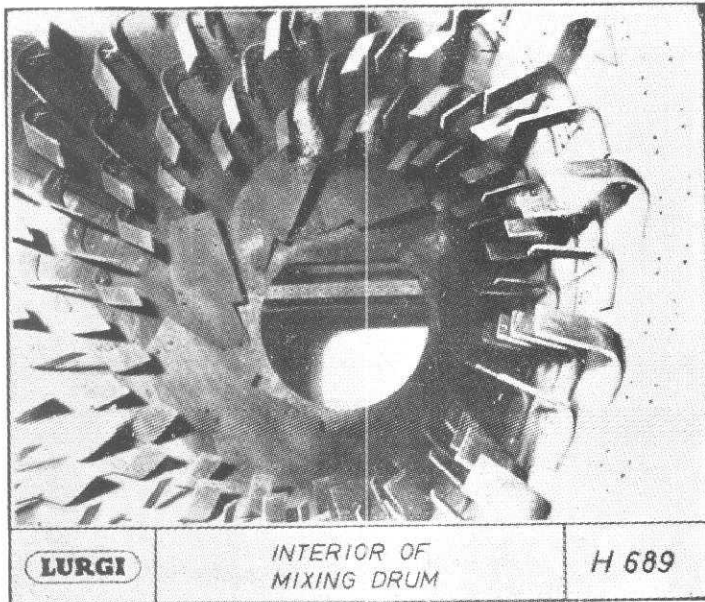


Fig. 5.

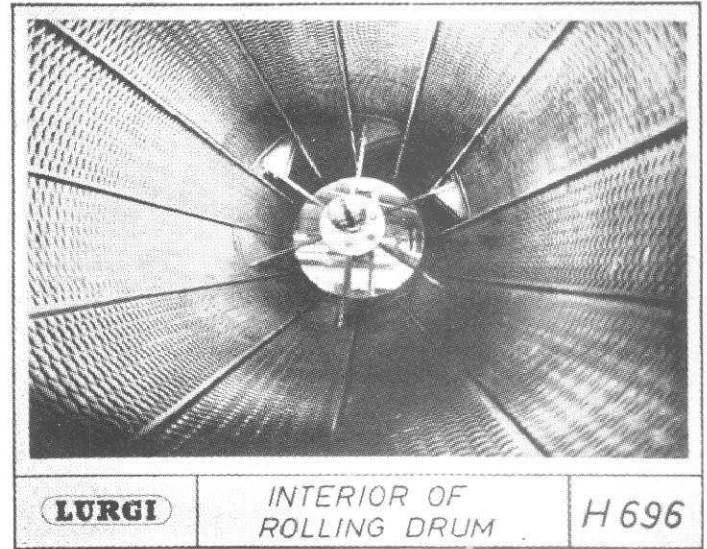


Fig. 6.

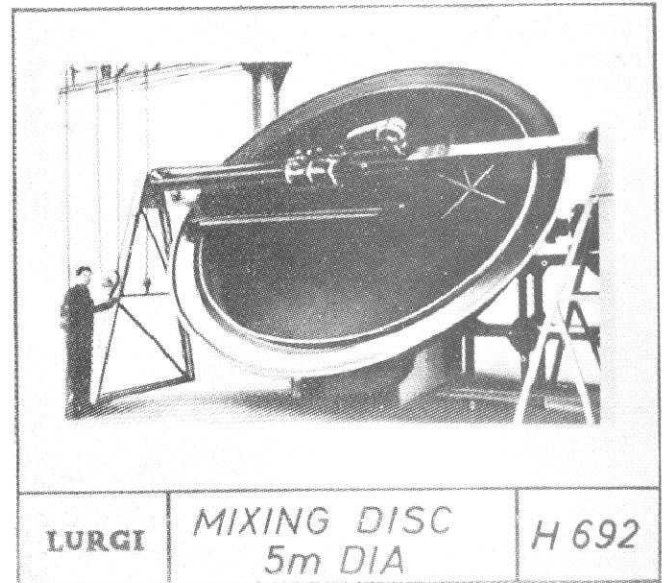


Fig. 7.

How, then, can these different mixers be employed to carry out the different processes described above?

- (i) The forced mixing units, the mixing drums and the discs are all suitable for mixing and wetting.
- (ii) The disc and the rerolling drum are suitable for rerolling or granulating.

The possibilities given by the availability of the different types of mixers for influencing the raw mix and the knowledge that the above mentioned processing stages have great influence on the preparation of the most suitable mix have, particularly in recent years, stimulated an intensive research in this field which made it possible to ascertain in particular the influence on the sinter output, the coke consumption and the sinter quality, the latter meaning both sinter strength and its reducibility. The reducibility of the sinter is closely related to its homogeneity which is of great importance in particular with self-fluxing sinters. For example if the sinter produced contains patches with excess lime this is due to improper mixing. Such sinter along these patches is particularly crumpley. The reducibility of other parts of the sinter is decreased because of lack of lime content in them. This can impair the advantages of using the self-fluxing sinter. In this connection it is worth mentioning that in many cases it will be practical to stabilise the analyses of the ores by having them run over a system of mixing beds prior to admitting them into the sintering plant.

The extension of the various processing techniques by introducing the process of rerolling the sinter mix, as well as the existence of different types of mixers, has recently often complicated the selection of the most suitable mixing system when building new plants. In order to facilitate an evaluation of the individual possibilities, this paper should put some light on the different mixing processes including their influence on various kinds of mixes, in particular the two-stage mixing process, i.e. preparatory mixing in a mixer and rerolling of the mix in a rerolling or granulating unit.

Table I enumerates the different combinations of mixers for the sinter mix. The resulting possibilities of mixing in one or two stages can be extended by altering the point of adding return fines, in other words, by arranging the addition either before or after the mixing. A variation can also be effected by using either hot or cold return fines. In this connection it may be mentioned that the use of hot return fines has in many cases resulted in an improved sinter output obviously by the loosening effect of the steam produced by the addition. Many of these numerous possibilities can often be eliminated straightaway in consideration of local conditions. This applies also to new projects where lack of space frequently limits the site of mixing station.

In dealing with the different possibilities it should be noted that with many ores the two-stage

TABLE I.

	MIXING	RE-ROLLING
ONE-STAGE PROCESS	MIXING DRUM PUG MILL DISC	— — —
TWO-STAGE PROCESS (PRE-MIXING AND RE-ROLLING)	MIXING DRUM " " PUG MILL " " DISC " "	RE-ROLLING DRUM DISC RE-ROLLING DRUM DISC RE-ROLLING DRUM DISC
LURGI	ONE-STAGE AND TWO-STAGE MIXING.	H 663

mixing process, i.e. preparatory mixing and subsequent rerolling is of special interest. How each ore or mix of ores will react to rerolling cannot be predicted without actual tests. Most of the ores react positively to rerolling, but on some of them rerolling has no influence at all, or even a detrimental one. In Table II a survey of the major characteristics of the different types of ores, as well as their behavior during two-stage mixing is given. This breakdown, however, is only a rough one and in the last resort only a test will furnish an accurate information.

The possibility of influencing both sinter output and quality by rerolling is of fundamental interest not only for the normal method of single-layer sintering but also for two-layer\*<sup>2</sup> sintering and mixed firing<sup>†</sup><sup>3</sup>. This latter

TABLE II.

A) WITHOUT INFLUENCE	SINTER MIXTURES WITH A SUFFICIENT AMOUNT OF COARSE CONSTITUENTS ABOVE 2mm AS WELL AS SINTER MIXTURES WITHOUT CONSIDERABLE PORTION OF VERY FINE MATERIAL BELOW 0.1mm AND WITHOUT PLASTIC PROPERTIES, E.G. HEMATITE WITH A HIGH FE CONTENT AND 70% OF GRAINS > 1mm	
B) POSITIVE INFLUENCE	SINTER MIXTURES WITH PLASTIC PROPERTIES AS WELL SUCH WITH A GREAT PORTION OF VERY FINE MATERIAL, E.G. ORE MIXTURES FROM CONCENTRATES, CINDERS, FLUE DUST ETC.	
C) NEGATIVE	VERY COARSE SINTER MIXTURES AND VERY PLASTIC SINTER MIXTURES E.G. COARSE-GRAINED MINETTE	
LURGI	INFLUENCE OF RE-ROLLING ON SINTER MIXTURES	H 664

\* German patent 103 5040

† German patent 914 355

<sup>2</sup> H. Wendeborn—Stahl und Eisen 71 (1951), Volume 21, pp. 1212-1218.

—Symposium on Sinter 1953, Special Report 53, pp. 1-9, Iron and Steel Institute.

<sup>3</sup> H. Rausch and K. Meyer—Stahl und Eisen 78 (1958) Volume 9, pp. 600-606.

method has been developed by the Lurgy Company during the last few years in order to substitute some of the coke breeze, a material both short in supply and expensive, by the blast furnace gas which is frequently available as an excess in many plants.

It has already been mentioned that the ores react in different ways to the two-stage mixing process, and to illustrate this statement, the general known possibilities for the different types of ores are shown in Fig. 8

*Type of ore A*

*Rerolling has no influence:* Sinter quality and output are not or very slightly influenced by rerolling.

*Type of ore B*

*Positive influence of rerolling:*

*Type of Ore B<sub>1</sub>*

Sinter output increases.  
Sinter quality remains constant.

*Type of ore B<sub>2</sub>*

Sinter output remains constant.  
Sinter quality improves.

*Type of ore B<sub>3</sub>*

Sinter output and quality improve.

*Type of ore C*

*Negative influence of rerolling.*

*Type of ore C<sub>1</sub>*

Sinter output remains constant.  
Sinter quality deteriorates.

*Type of ore C<sub>2</sub>*

Sinter output increases.  
Sinter quality deteriorates.

In the case of ore C<sub>2</sub> the sintering result can sometimes be influenced in a positive way by increasing the amount of return fines in the mix in order to increase the strength of the sinter. In

this way it may be possible that with keeping the coke ratio relative to the ore constant the sinter output in spite of the increased amount of return fines could be increased. In this case the ore would have to be classified under group B<sub>1</sub>.

**Testing device**

The subsequently reported results were obtained from sinter tests in a pan. The sintering pans employed as shown in Fig. 9 have a suction area of 0.16m<sup>2</sup>, each. Fig. 9 provides a general view of the testing pan and the measuring instruments. It may be mentioned that the test results obtained on these pans can be transferred to actual practice and are reproducible.

The following equipment was available for mixing and rerolling the different mixes or ores:

- (i) The forced mixer, type Eirich;
- (ii) 1 double-shaft pugmill;
- (iii) 1 mixing drum;
- (iv) 1 rerolling drum; with adjustable speed of rotation;
- (v) 1 pelletising disc, with adjustable inclination and speed.

The sinter output is stated in tons of sinter per m<sup>2</sup> of suction area and day and refers to hot discharge, in other words, the sintering test was terminated when the waste gas attained its maximum temperature.

By sinter quality within the scope of this paper only the strength of sinter is meant. The sinter strength was determined by letting the entire sinter cake fall three times from a height of 2 m. The proportion of sinter above 8 mm, obtained after carrying out this shatter test, is entered as measure for the strength in tables and graphs.

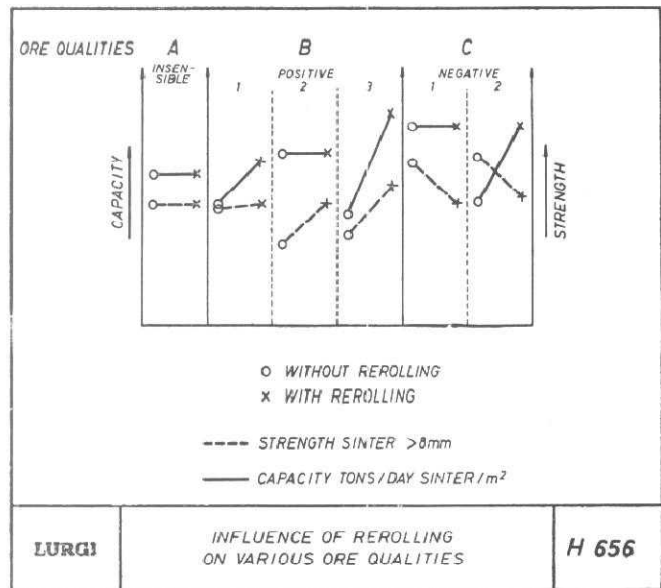


Fig. 8.

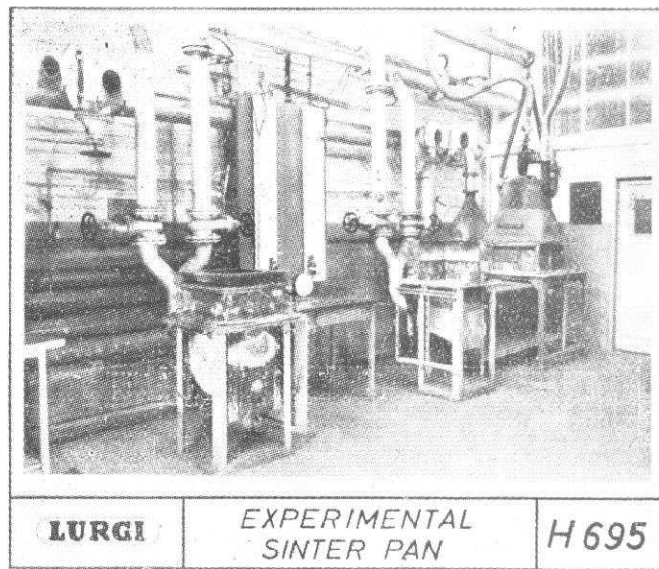


Fig. 9.

## Test results

To illustrate the above general statements some test results will be discussed now. In the first place the influence of various mixing systems on the sintering process will be dealt with. This is shown in Fig. A-D which illustrates the results of sinter tests performed with different ores adopting some of the mixing methods listed in Table I. The individual mixes used are:

- A. Minette ore mix.
- B. Mesabi ore with and without flue dust.
- C. Venezuelan ore with and without flue dust.
- D. A mixture of ores consisting of Sydvaranger concentrate, fine ores, pyrite cinders and flue dust.

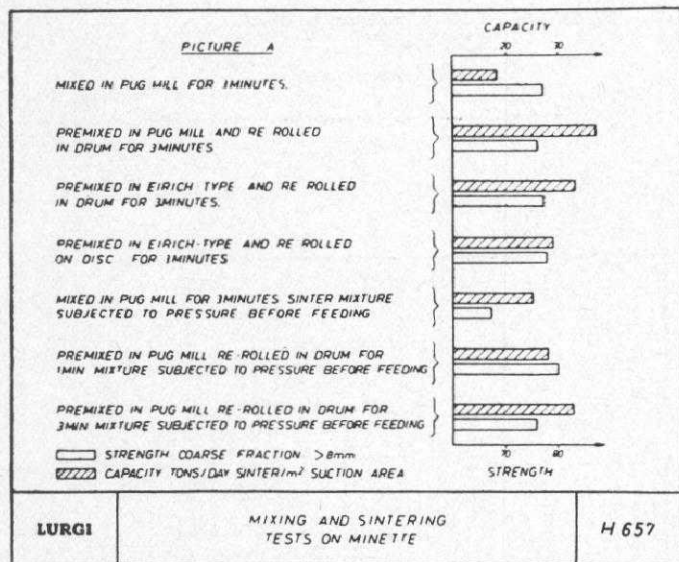


Fig. A.

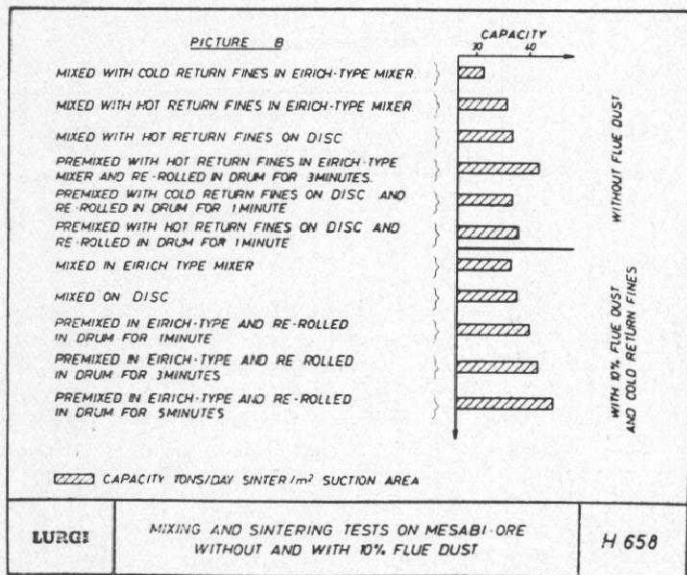


Fig. B.

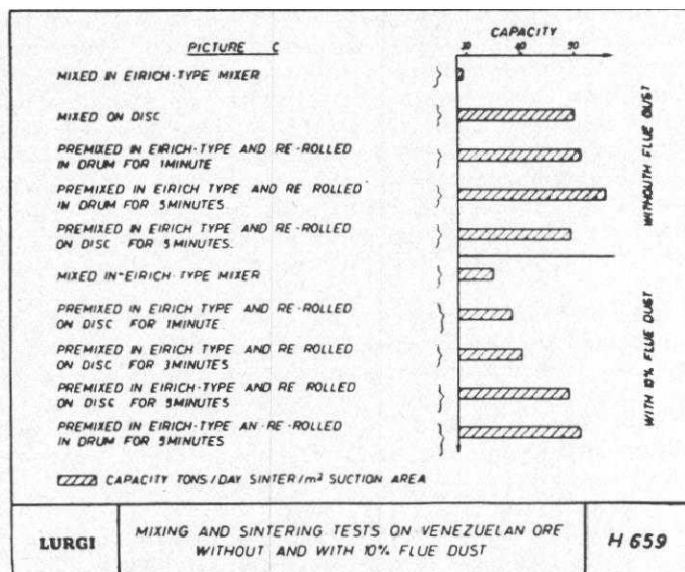


Fig. C.

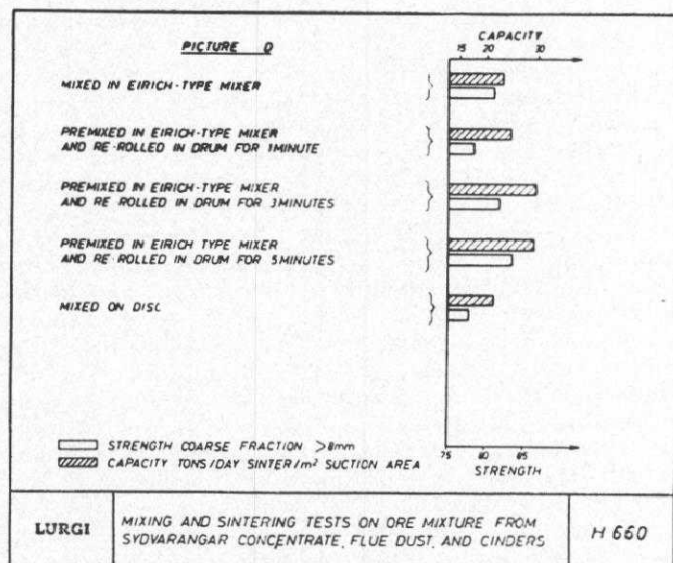


Fig. D.

It is quite clearly shown that each of the ores listed above shows a different reaction to the various mixing methods. It is not intended to discuss these results in details which can be easily seen in the diagram. Only the results of different test series can be summed up as under:

With minette ores the best results as far as quality and output are concerned, are obtained by preparatory mixing with subsequent secondary treatment in a rerolling drum. Further, these tests reveal that this mix if not re-rolled, is sensitive to drop while the re-rolled mix no longer reacts in this way.

In the case of Venezuela ore without flue dust the easiest way might be to mix this ore with coke and return fines on the disc without any rerolling, although the tests with rerolled mix show somewhat more favourable results as far as the output is concerned. The same applies to the Mesabi ores without flue dust. Another fact revealed by the tests with Venezuela ore is the interesting influence of cold or hot return fines on the sinter output as well as the influence exercised by the point of addition of the return fines.

If, however, 10-15% flue dust are added to Venezuela or Mesabi ores, the superiority of two-stage mixing over the one-stage mixing on the disc is more pronounced than with mix without flue dust.

The mix in case D does not react at all to one-stage mixing on the disc. With this kind of mix two-stage mixing is superior in any case.

*For the two-stage mixing\* consisting of preparatory mixing and wetting in the first stage and rerolling in the second, the following results are of interest :*

In general it can be said that in most cases the two-stage mixing for preparing the sinter mix is the surest method. It is, above all, preferable in all those cases where the raw sinter mix consists of several components or where its composition might frequently be subject to changes.

Some interesting details are contributed by R. Parker<sup>4</sup> in his article "Research Leading to the Design of the Guest Keen Iron and Steel Sintering Plant". It is important that the rerolling drum should be correctly designed. An optimum rerolling effect can be obtained only if for the rerolling drum proper size, number of revolutions and degree of fillness are chosen.

The influence of the rerolling time on the sinter output of different mix is shown in Fig. 10. Whereas with ore A, for instance, the optimum output is obtained after a rerolling time of 1-2 minutes, an increase in rerolling time having no influence at all, the output continuously increases in the case of ore B, within a rerolling time of up to 5 minutes. The size of the rerolling drum naturally depends on the required rerolling time.

Ore C does not react to the rerolling process at all. The curve in Fig. 11 gives an idea of the connection between speed of rotation of the rolling drum and sinter output and its quality. Here, too, the ores react in different ways. According to Parker the optimum speed of rotation should be 25-35% of the critical speed of rotation.

$$\text{crit. rpm} = \frac{60\sqrt{rg}}{2\pi r}$$

If the speed is excessive, the ore no longer rolls, but cascades.

\* U.S.A. patent 2858204  
Aust. patent 214417

<sup>4</sup> R. Parker—Blast Furnace and Steel Plant 1957, Volume 45, pp. 1395-1405.

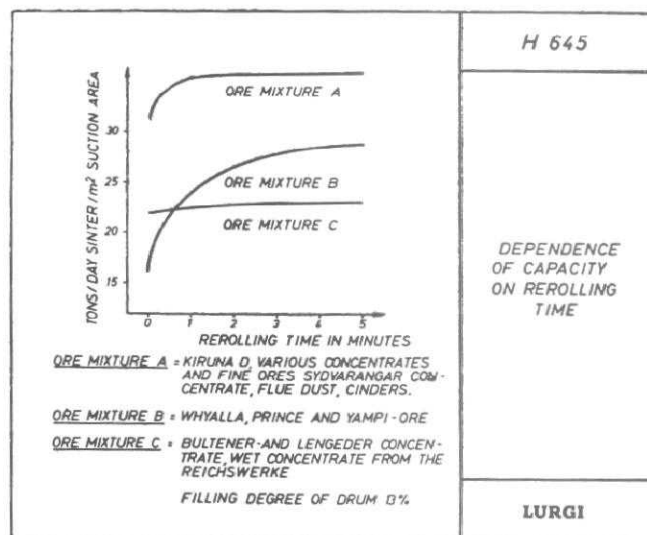


Fig. 10.

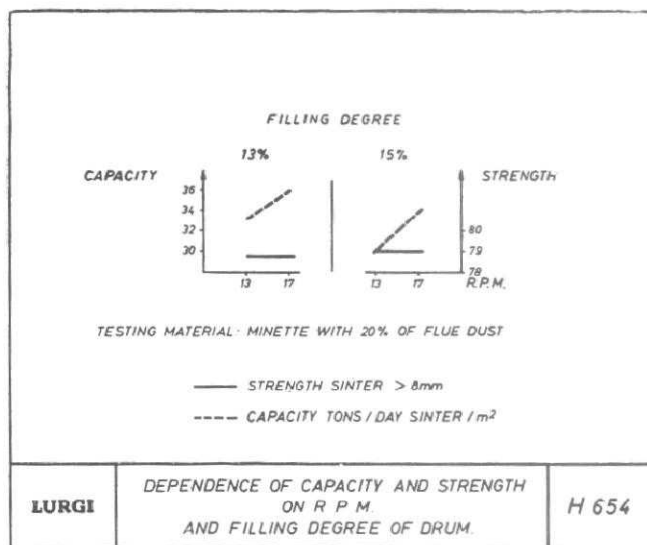


Fig. 11.

On the other hand the speed chosen should approach the maximum speed allowed for the respective ore as far as possible, as by doing so, the rolling path is lengthened. The rolling path for an ore particle in a unit time is shorter for a slowly rotating drum. The path covered by the particles during the rerolling operation is amongst all the most important factor.

Fig. 13 shows again the influence of the degree of fillness on both sinter output and quality. The degree of fillness chosen should be as high as possible in order not to enlarge the rerolling drum unnecessarily.

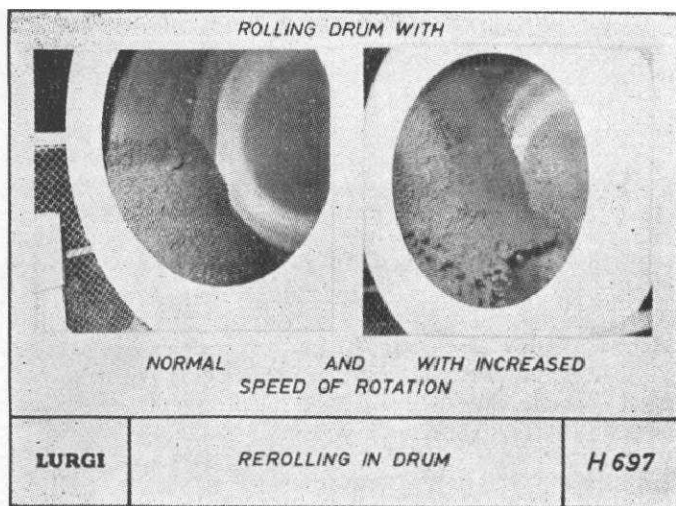


Fig. 12.

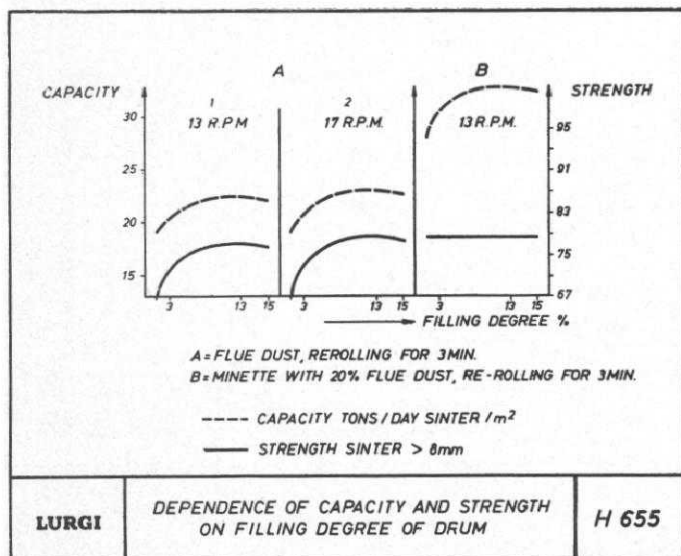


Fig. 13.

In general the optimum degree of fillness lies between 12 and 15%, as also given by Parker. The picture shows that in the examples quoted for sintering flue dust and optimum sinter output and quality is obtained with a degree of fillness ranging between 12 and 13%. If the degree of fillness is higher, for example 15%, both output and quality are affected in a negative way. This applies both to a speed of rotation of 13 and 17 r.p.m. At 17 r.p.m. the absolute figures are slightly more favourable than 13 r.p.m. In case of Minette with 20% flue dust only the output is influenced by the degree of fillness whereas the quality is not

affected. The output declines to some extent, if the degree of fillness is kept too high.

Similar relations are also indicated in Fig. 11. Once again Minette ore with 20% flue dust was used as test material. The tests were carried out first with a degree of fillness of 13% and then with 15%. Each test series was performed at a speed of rotation of 13 and 17 r.p.m. In this case, too, the sinter quality remains constant, and it was clearly shown that an optimum output is reached with a degree of fillness of 13% at 17 r.p.m.

Although it is possible to establish general basic rules about the speed of rotation and degree of fillness of rerolling drums, the final accurate details can only be ascertained by way of experiments, and in practice, too, it will undoubtedly be feasible to obtain noticeable improvements in the sintering plant, both in output and in quality, by exact study and adjustment of the mixing system. Unfortunately, too little attention is frequently paid to this important point.

The rerolling of the sinter mix does not as a rule produce any defined and regular pellets. As already mentioned it consists rather in rolling of the finest particles of the sinter mix into already existing coarser ones, for example of return fines or ore. This will make the sinter bed more permeable and thus raise the output. It is even very often undesirable to obtain pellets which are too regular and too perfect, as this may affect the strength of the sinter produced.

Fig. 14 shows two samples of the same mixture of ores, one of which (A) was not subjected to rerolling, while the other one (B) was rerolled. One can clearly recognise the difference in the structure of these two samples.

A subject which is being discussed these days is the use of the pelletising disc as mixing unit.

Some test results in this connection have already

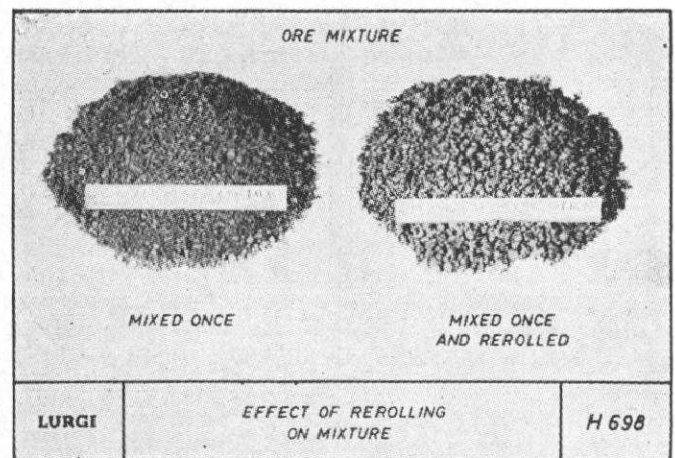


Fig. 14.

been mentioned. In case of the disc also the mixing and rerolling effects and hence the sinter output and quality will be influenced by the speed of rotation and degree of fillness. However, not many results are available as contrary to the mixing drum it is difficult to keep the correct relationship between the disc size (diameter), degree of fillness, angle of inclination and number of revolutions in course of tests with the disc.

The principal effect of raising the rim of the disc will be to increase the degree of fillness of the disc, in other words, while the average retention time of the material to be mixed on the disc remains constant, the throughput rises. The same disc, when its rim is raised, must wet, mix and possibly reroll far more material in the same unit of time than a disc with a lower rim. However, where high outputs are involved, such as in iron ore sintering, the only possibility of obtaining higher output with sufficient mixing time is by raising the rim as the other alternative of increasing the throughput by enlarging the diameter is restricted by design difficulties.

Mixing drums can be enlarged to quite a considerable extent both as regards diameter and length, so that one drum will be able to process even such large quantities as 600 t an hour and more without any difficulty. The discs thus far constructed had a diameter of not more than 5-6 m. As a result in case of higher output it is necessary for getting a sufficient mixing effect to install two or more discs. This will require dividing the material to be mixed into two or more flows which make the mixing plant complicated.

In the case of plants already in service a complication of this kind has proved to be a definite disadvantage. Having previously compared the throughput of disc and mixing drum it is of great importance to consider the difference in the mixing performances. The test results show that the mixing disc can be used with success only in such individual cases where favourable conditions are offered due to the quality of the ore. These conditions are above all an uncomplicated mix consisting of a few components only and the ore possesses such physical quality that it does not require too intensive mixing. This applies, for instance, to Venezuela and Mesabi ores. For other mixtures of ores, especially those made up of different mixtures of ores, a mixing disc will be out of the question, since the retention time of the material to be mixed thereon is insufficient to allow any intensive mixing. This applies in particular also to the rerolling process, where due to the short retention time a rolling effect will not be realised. In all these cases the use of mixing and rerolling drums is to be recommended, since these devices can cope with all the fluctuations in the composition and quality of the ores and will guarantee a sufficient mixing and rolling in every case.

In conclusion some special cases of mix preparation may be mentioned.

In these cases the above mixers are used. The so-called pellet-sintering process<sup>5</sup> is generally known. This process consists of sintering 3-6 mm pellets of very fine-grained ores, mixed with coke and eventually return fines. This process, however, can be used only if the same ore of suitable fineness is constantly supplied and the pellets produced are strong enough to stand up the subsequent mixing with return fines and coke.

Once these conditions are fulfilled, it will be possible in special cases, when producing pellet sinter to obtain considerable advantages over the normal sintering process, as shown in Table IV, where the normal sintering process is compared with the manufacture of pellet sinter.

The material involved is extremely fine-grained flotation pyrite cinder. The sinter plant is to be installed in combination with the roasting plant from

TABLE III.

ADDITION OF CONCENTRATE	RE-ROLLING		PARTIAL PELLETIZING	
	5%	25%	5%	25%
CAPACITY (TONS / DAY SINTER m <sup>2</sup> )	31.7	25.5	33.1	30.1
SINTER > 8mm %	66	70	63	64

**LURGI**      **COMPARISON OF PARTIAL PELLETIZING AND RE-ROLLING**      **H 661**

TABLE IV.

	COKE BREEZE	RETURN FINES	CAPACITY	REMARKS
NORMAL SINTERING	%	%	TONS / DAY SINTER m <sup>2</sup>	SINTER CAKE INCLUDES UN-SINTERED PATCHES
"PELLET SINTER"	9.2	90	13	
	7.3	40	19	VERY GOOD SINTER QUALITY

\* REFERRED TO CINDER

**LURGI**      **COMPARISON OF "PELLET SINTER" AND NORMAL SINTER FOR FINE-GRAINED CINDER**      **H 662**

<sup>5</sup> K. Meyer—Stahl und Eisen 76 (1956), Volume 10, pp. 588-595.

which this fine-grained cinder is made available always in the same quantity and quality. This table clearly shows that the said pellet sinter will cause not only a marked increase in output, but also a reduction in the amount of circulating load as well as in coke consumption.

Another process (Table III) generally known consists in pelletising only the fine-grained ingredients of a sinter mix and in mixing the pellets thus produced with the other ore carriers, as well as return fines and coke. This process is considered, for instance, where part of the mix consists of extremely fine concentrates, such as flotation and magnetic concentrates, but it will, of course, be of advantage only if with regard to both sinter quality and sinter output it shows results superior to those obtained from rerolling the entire sinter mix. Moreover, the pellets thus produced must be strong enough to survive the subsequent mixing process. In the examples shown in the table both these conditions are fulfilled, so that in this case the various ways of carrying out a partial pelletisation would appear to be of interest.

With this ore, a minette mixture, some test series were conducted by adding 5 and 25% concentrate. In one case the entire mix was rerolled.

In another case the concentrate was added in the form of pellets measuring between 3 and 6 mm, but although the increase in output was very pronounced in this last case, the strength of the sinter was slightly reduced.

## Summary

The importance of proper preparation of the mixture has grown with the development and perfection of sintering plants and it has become generally known that satisfactory sintering will largely depend on the application of an adequate mixing method. A description is given of the types of mixers and of the granulating equipment that are presently applied in commercial operation.

Under certain conditions it is possible and, at times, even indispensable to reroll the mix after the mixing process proper, in order to achieve an improvement of capacities and qualities. A description is given of these conditions. Suggestions and recommendations are presented as to the types of mixers that are best suited for mixing and as to those most suitable for rerolling.

The influence of the mixing process on sintering is demonstrated on the basis of typical sinter mixtures of very different compositions. The conclusion will be drawn that there is no one optimum mixing method which can be applied to every kind of sinter mix. In each individual case it will be necessary to find the most suitable mixing method by means of tests.

This is to be a contribution to laying stress on the importance of having adequate mixing methods for the sintering of iron ores.

## DISCUSSIONS

*Mr. Rogers, B.H.P., Australia:* As mentioned by many speakers in these sessions, we have in Australia a large percentage of -200 mesh ore, and I cannot agree with the views expressed by the authors regarding the question of rerolling and in fact, in a sinter plant we are currently building, we have ourselves changed the name of the second drum from "rerolling drum" to "secondary mixer". The question of additions in this mixer may be of some importance because you can add coke fines to be taken up on the outside of the pellets. It has been our experience that if you take ores without a high percentage of return fines and pelletise them as such and if that pellet has not got a return fine as a nucleus then the sintering

rates are found to go down very appreciably. May I invite Dr. Brandes' comments on this?

*Dip. Ing. G. Brandes, Lurgi Gesellschaft für Chemie und Huttenwesen G.m.B.H., Frankfurt/Main:* I agree with Mr. Rogers as far as their mix is concerned. As can be seen in Fig. 10 of the paper this mix needs much longer rerolling time than the other mixes. In consideration of the great number of tests carried out the authors do believe that the statements contained in the paper can be generalised. As already mentioned in the paper the purpose of rerolling partly is to pick up fines which were not picked up during mixing. There is only a difference in the names given to the stages of mixing but there is none in the procedure.