MILL DRIVE TECHNOLOGY PRESENT AND FUTURE
PRESENTE Y FUTURO DE LA TECNOLOGIA DE TRANSMISIONES PARA MOLIENDA

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Abstract- Cane Sugar Mill section consumes most of the total required power per ton/cane milled. The main reasons for the high power consumption at milling are un-efficient drives and multiple speed reducing equipment, foot mounted technology is still very popular in milling. Over the years there have been various efforts conducted to reduce power requirement at milling. Mill design, Transmission design, mill geometry and many things have changed to reduce the power consumptions. Operations are focused to reduce the mill load by improving the cane feeding as well as its preparation. Mill are taking more TCH of same dimensions but overall power requirement has not reduce drastically yet. This article reviews the innovative transmissions for milling and the studies that Reggiana Riduttori has done in the last years to improve shaft mounted planetary drives and to reduce power requirement at milling. This technology has shown great results in terms of reducing power consumption during extraction and also improved milling performance of crush rate, extraction and maintenance.

Key words: Mill Transmission, Mill Efficiency, Power Saving, Better Extraction, Planetary Drives

Resumen- La área de los Molinos consume la mayoría de la energía requerida por cada tonelada de caña molida. La razón principal de este alto consumo es debido a transmisiones non eficientes y con varios equipos armado en piso para reducir la velocidad. En los últimos 10 años varias soluciones se han desarrollados y implementados para reducir el consumo de energía en los Molinos. Diseño y geometría de los Molinos, setting de los Molinos, diseño y tecnología de las Transmisiones y varios otros elemento han sido cambiados para reducir el consumo de energía. Ingenios están enfocados en reducir la carga en los molino mejorando la preparación y la alimentación de la caña. Los Molinos están moliendo más TCH con las mismas dimensiones de las mazas pues el requerimiento de energía no ha bajado. Esta ponencia evalua las transmisiones más avanzadas por Molinos y muestra los estudios que Reggiana Riduttori hizo en los últimos años para mejorar las soluciones de reductores planetarios armados en flecha y optimizar el consumo de energía en los Molinos. Estas soluciones han mostrado resultados excelentes en términos de reducción de energía, mejora de molienda, extracción y mantenimiento.

Palabras claves: Transmisiones de Molinos, Eficiencia de Molienda, Ahorro Energía, Mejor Extracción, Reductores Planetarios

Introduction

Since the inception of the cane milling we have been installing most of the drives for various application with different supports like: frame support or strong civil foundation support. Sugar industries worldwide has used or still uses one of the following drive technology.

Generation One : Steam drive Engine with open bull gearing full reduction system. (Three to four big bull open gearboxes still operational in few mills).

Generation Two : Steam turbine with open bull gearing full reduction system

Generation Three : Steam Turbine followed by high speed gearbox and open gearboxes (Still operational in many sugar mills worldwide)

Generation Four: Steam Turbine followed by high speed gearbox and helical gearbox (Still operational in many sugar mills worldwide)

Generation Five : DC drive electrical motors followed by high speed gearbox and helical gearbox (Still operational in many sugar mills worldwide)

Generation Six : DC drive motors followed by one helical gearbox. Hydraulic independent drive mills.

Generation Seven : AC VFD or DC drive motors followed by foot mounted planetary gearbox. (Widely used with rope coupling and crown pinion)

Future Generation – AC VFD motor with shaft mounted planetary gearbox or pinion less drive system.

The foot mounted mill gearbox is resting on civil foundation and is coupled to the mill through rope coupling or tail bar. The rope coupling devices grants more efficient transmission than the tail bars, they also allow flexibility for misalignment. The crown pinion transmission which is less efficient and creates big stress impact on the headstocks, top roller shaft and bearing is still used regardless. These pinions have less transmission efficiency and consume around 8 -12% power due to the loss in friction. This also restricts the variable mill rollers speed which gives better extraction; it is also observed that best way for operating the mill from a mechanical and operational point of view is to keep the torque distribution between the rolls (pressure in the hydraulic systems) at: 50, 25, and 25 %.

Again in the foot mounted single drive system, one gearbox takes over all the load and the system inertia, due to mill variable speed, depending upon cane flow accelerations but most important decelerations crates heavy inertia which increases heavy stress on gears. This is heavily effecting gear life. Market demand is for bigger mills in order to increase overall efficiency and reduce operation costs, but there is an important limitations as for the motor sizes and gearboxes : one single big gearbox, motor, VFD etc. is not easily available, also spares related to it are very costly.

Limitations of the Single foot mounted technology :

- Massive civil foundation requirement for gearbox intallation
- Big base frame and support required
- High skills required for alignment
- Big size gearbox hence long delivery
- Huge inventory costs for spares like bearings/carriers etc. or stand by gearbox
- No flexibility of independent speed
- Limitations in mill settings
- Power transmission efficiency loss due to pinion/tail bar/rope coupling etc
- No flexibility during expansion as power and drive capacity is bottle neck
- No easy replacement possibilities during shut down
- Limitation during shock load
- High down time for replacement if pinion or tail bar or rope coupling fail.

Hydraulic Independent drive technology
Since late 1990 this technology has been running. Many factories are still following this technology but it shows some limitations and disadvantages :

- High start up investment
- High maintenance costs
- Efficiency depends upon oil quality and pressure
- Limitations on speed variations
- Limitation of performance during certain operation parameters
- Highly skilled maintenance and operation staff required
- High operational cost

New Shaft Mounted Technology _ Reasons of our Studies and Developments:

Years of market surveying and observation of the sugar industry operations conditions have been a valuable source of data where to work on, with our studies we have gathered that the efficiencies of the conventional systems are quite low and needed to be improved:

Conventional systems drive efficiencies :

1. Turbine and Open gearing – 30-45%
2. Turbine, High speed gear and open gear- 40-55%
3. Turbine and helical gear with one low speed gear – 60-65%
4. Turbine/Motor with one single helical gear – 70%
5. Planetary Foot Mounted and Motor – 70-78%
6. Shaft mounted planetary with AC VFD – 88-90%

A new design was needed , a solution that could be mounted directly on mill rollers through different types of devices to accommodate different sugar plants configurations, a solution that must avoid any loss of transmission granting top efficiency

Here is where Reggiana Riduttori shaft mounted planetary drives comes in, designed and manufactured according to top quality standards to offer a system that could grant power saving at milling.

This innovative system consists in two drives that can be directly mounted one on each top and bottom rollers keeping the same motor configuration. This system has been then widely welcomed by the market for following benefits:

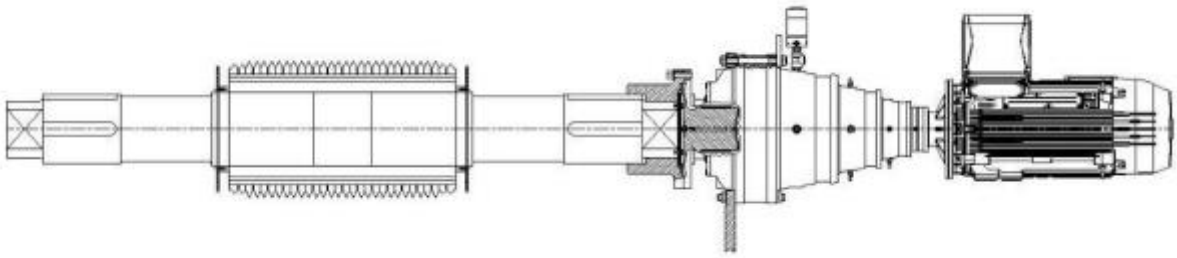
1. Lowest power consumption rate per ton of fiber for milling.
2. Elimination of crown pinion.
3. Elimination of tail bar.
4. Elimination of civil foundation, base frame etc. for the gearbox
5. Horizontal forces on top roller bearing are reduced of 40%
6. Reduction of the mill headstock stress by 35%
7. Reduction of the mill rollers stress by 51%
8. Less wear of mill component. Hence extended life cycle.
9. Small foot print for milling tandem.
10. Variable mill roller speed hence better extraction.
11. Better control on mill speed and torque.
12. Reversible movement possible great advantage during mill chocking.
13. Easy maintenance
14. Less inventory
15. Flexibility on mill setting.
16. Better shock load absorption and control.

Even if efficiency and power saving was Reggiana Riduttori main goal, while developing the new system we have also considered that the drives needed to respond positively to the following increasing market needs:

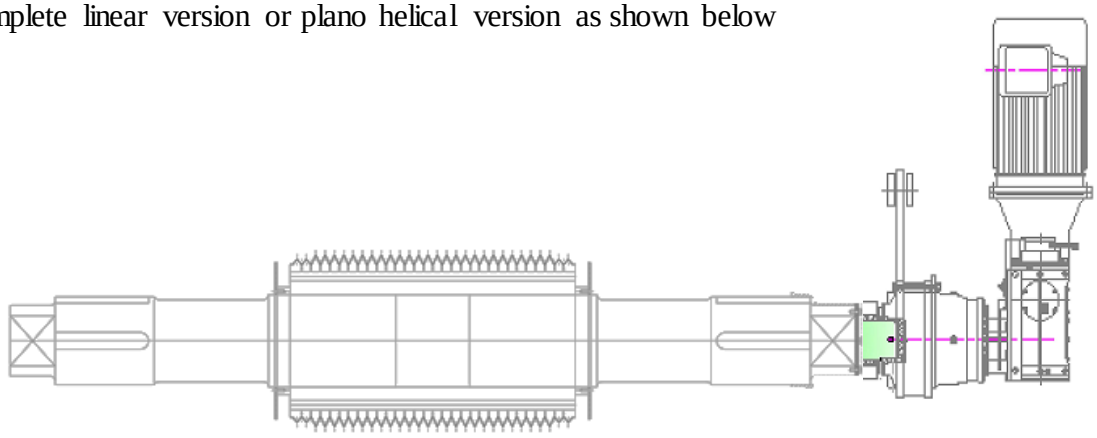
1. Industry needs to get more benefits through power selling. (Applicable to countries where bio-energy power sell gets premium)
2. Increase through put on same milling tandem
3. Existing power is bottle neck.
4. Existing drive system is old and un-efficient
5. High maintenance cost of existing drive system
6. To improve milling performances station
7. To improve the life cycle of mill component

Flexible arrangements of shaft mounted planetary drive on mill roller .

Shaft mounted planetary drives can be mounted in various combinations on mill to respond positively to the different space availability and mill configurations around the world. The most frequent is the shaft mounted gearbox as shown in below figure.



Depending on the motor size , overhung load and space constraint one other very frequent installation is a complete linear version or plano helical version as shown below

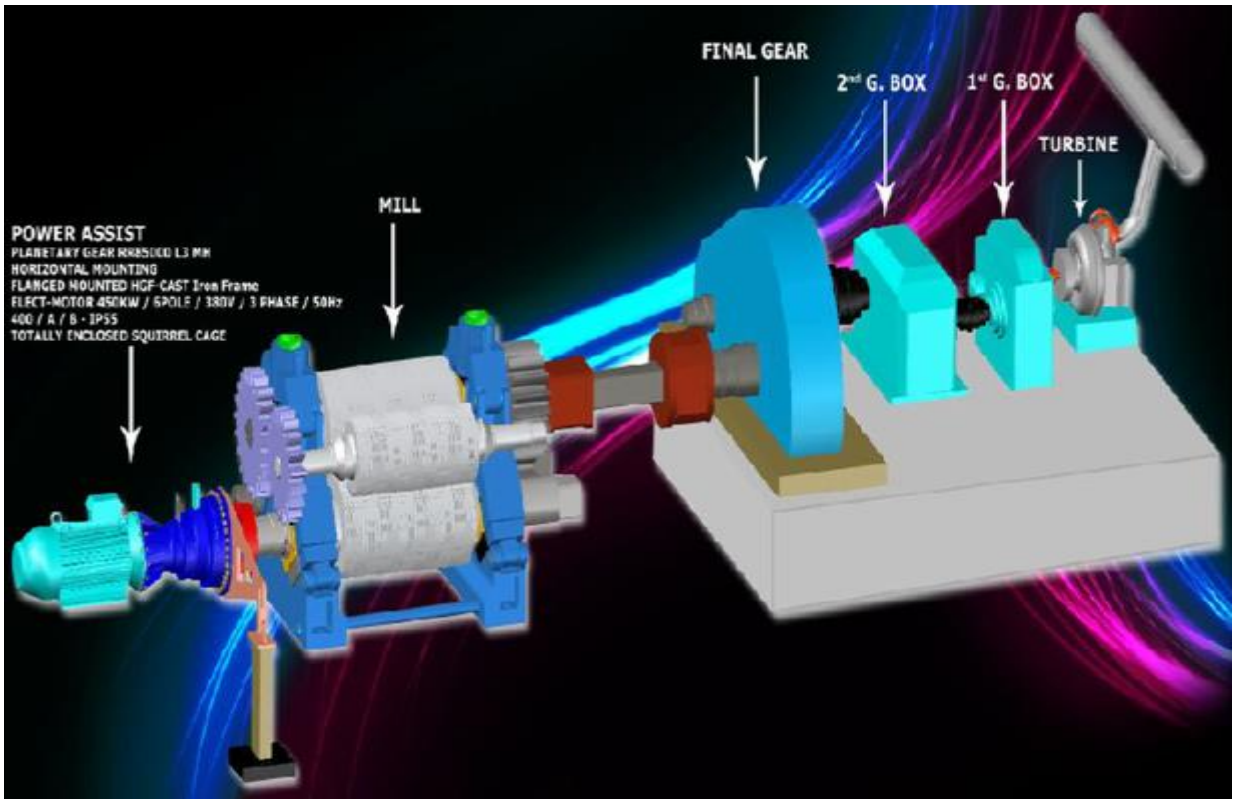


Assist drive to upgrade your current mill

The most critical points during the mill expansion are: space, time and number of items to be replaced form the existing structure. Shaft mounted drives fits perfectly into all this. Most of the time mill sizes are sufficient to crush higher cane but their main constrain is the installed power. With shaft mounted drives it's possible to increase installed power of existing tandem with very few modifications and without having to replace the existing system. This solution we call as "Assist Drive".

Assist drives can be mounted on additional drive of top, feed, discharge or Underfeed roller and the total mill installed power can be increased. This is the winning solution when the mill needs to improve the crushing rate on existing tandem without having to replace the existing headstock and drives. Furthermore these drives act independently, in fact they can be easily synchronized with the existing mill automation system. Good part of these type of installation is torque on independent roller can be controlled well.

Installation concept is shown in below picture.



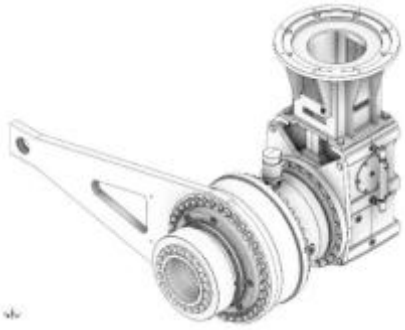
Basic design and selection criteria

A good sugar process understanding is the key for a correct selection of sugar mill planetary gearbox. It is important to know the crushing cycle, the type of speed variations, absorbed torques, frequency of speed variation, predicted life cycle requirement etc. A perfect example is the operation season variation from country to country Thailand mill operations are 120-150 days long, while East Africa operations are 300 days long. Hence it is necessary to have a good understanding of the milling operation and gearing technology. The selection is based on ISO or AGMA standards and service factors in use for installed power are 1.6 to 2.5, lifetime on roller bearing L10hr $\geq$ 100,000 Hours. One other critical value is the input speed variation percentage. Higher the input speed and torque percentage variation is, higher the service factor needs to be.

Shaft mounted gearboxes configuration advantages

With Shrink disc :

Sugar mill roller shaft is mated directly to the gearbox hollow shaft, a shrink disc is fixed on the roller shaft which holds the structure. By applying simple oil pressure the shaft can be removed during maintenance. Diagram here below explain the same.



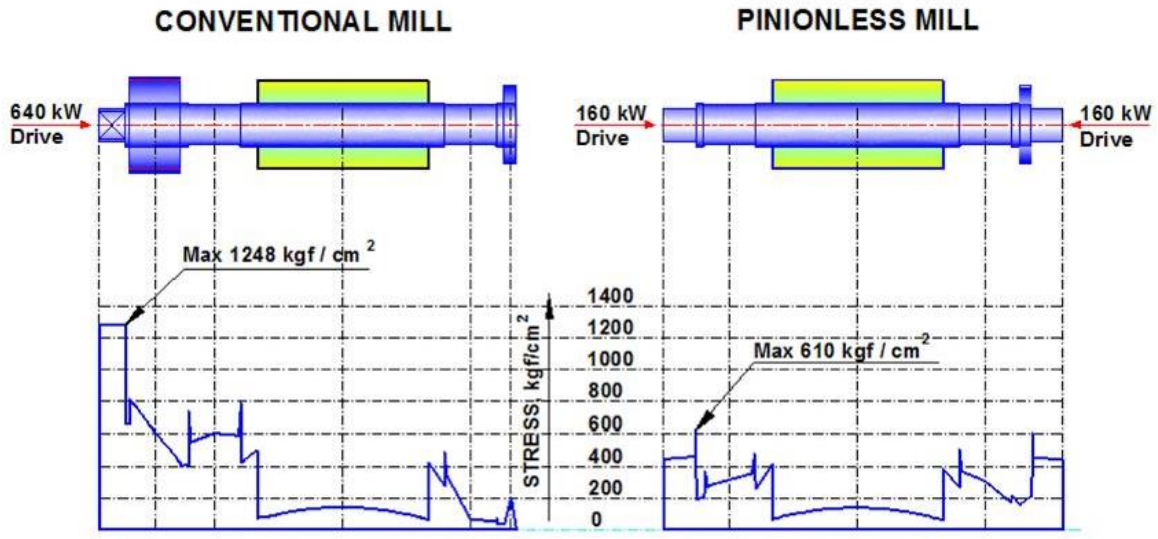
With Clamping Ring

In this configuration the gearbox has a female splined output shaft and a double centric flange is bolted in between the gearbox and the mill roller shaft. By simply removing the bolts on the mill roller shaft the gearbox can be detached. Photos below explain the same.

If we keep the same mounting configuration for all rollers and if the system is designed with two gearboxes on the top roller and one each on the bottom roller this gives great flexibility to mill engineer for shifting the mill rollers in tandem. This helps to reduce inventory by a huge amount as one or two sets of gearbox can be kept as spares and used among all mills depending upon number of mills.

Stress Diagram for Shaft Mounted mill.

Mr. D.K. Goel from ISGEC has presented a typical stress diagram for shaft mounted/pinionless drives at XXVIII ISSCT Congress in Brazil. It clearly indicates the reduction in stress on headstock, journals and bearings.



Results Achieved with Shaft Mounted first Mill installation (Data collected 2014 crop run)

Over the past nine seasons Reggiana Riduttori drives have been working efficiently in various sugar millss. Real results achieved by the sugar plant using RR drives are listed follows. Data collected during season 2013-2014

Sr. No.	Particulars	Data	Unit
1	Mill Size	40" x 80"	Inches
2	No of mills in Tandem	4,00	Nos
3	Average Crush rate for season	6000,00	TCD
4	Number of working days	165	Nos
5	Total Crushing	890.000,00	Ton
6	Average Cane Fiber	13,54	%
7	Pol % in baggase	2,05	%
8	Moisture % in baggase	48,27	%
9	Mill Extraction	94,84	%
10	RME	95,38	%
11	Average Power consumption	1,07	KwH/TCH/Mill
12	Wear on mill journal	Nil to 0,3	mm
13	Wear coupling area	Nil	mm
14	Wear on Mill roller bearing	Nil to 0,12	mm

Above results clearly show how the absorbed mill power is lower over all the drive systems arrangements explained during introduction. These figures are achieved with improved results in mill extraction, low pol in cane and moisture content in bagasse keeping the same or even higher crush rate.

It also shows clearly that the wear on the mill components is reduced to the minimum because of the less friction and the best adaptability of the top roller float. The drives have been working in good conditions for the last 6 seasons without any major maintenance on them and also at variable crushing rates from 4000 -6800TCD without compromising the mill performance results.

Secondary but not less important results achieved by the factory are: less oil consumption, less inventory, space cost (less foot print), fast return on investment, extra export power availability, and additional revenue from extra power saving, less maintenance cost and many more.

Our data collection from different countries is under elaboration and we will soon be publishing the more detailed advantages and calculation of shaft mounted drives.

Future of Drive technology

All above observations indicates that sugar plants need more efficient drives to reduce power requirement. If we see generation first drive where power consumption is almost 3Kw/TCH and if we observe the power consumption with independent Shaft mounted planetary drive we see almost 67% power saving. In other terms we have save in installed power as well as improved milling capacity.

Bio energy demand will be growing day by day hence factory will be forced to take actions to reduce power consumption and get benefit by selling available extra power. Factories need flexibility for crushing rate and also need more extractions of sucrosem , shaft mounted drives can easily help sugar plants do all this .

Miller have more mill setting possibilities and can set as per their requirement to gain from input cane. This flexibility can be only possible with Reggiana Riduttori shaft mounted technology.

Conclusions

With the growing concern for power export, it is the perfect time now to shift to shaft mounted high efficiency planetary drives for efficient milling. From the given data and various data published so far it is clear that the shaft mounted mill drives power consumption per mill is the lowest. It also proved that the cost for maintenance is significantly reduced by using shaft mounted drives.

Stress on the mill components is substantially reduced by a 50% it equals to an extended life of mill component and SHP can be increased to get more extraction.

Mill extraction data clearly shows that there is improvement and bagasse moisture are well under control below 49%.

It is well known that with shaft mounted planetary drive there is 50% civil cost saving for new mills.

Reggiana Riduttori is working towards more efficient mill transmission solutions and we are carrying out further work on exact torque distribution in mill, extraction improvement, mill speed variation control and optimization of crushing rate on existing mill tandem. Soon we will reveal more data which will be helpful for sugar millers.

We believe in “Save water and power and save the world”

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