



Speed reduction drives

Millers must determine the best type of drive system to use to get the required input speed for the machine the motor is driving

by Fred Fairchild

The shaft that turns a machine does not always match the speeds available from any motor or motor and gear reducer combination available. What type of drive system do you use to get the required input speed for the machine the motor is driving? There are two ways to do it: 1) Install an alternating current variable frequency drive (VFD), or 2) use a v-belt or chain speed reduction between the motor and the gear reducer or machine shaft to provide the proper input speed for the machine.

VARIABLE SPEED DRIVES

In many cases, it is desirable to vary the speed of a piece of equipment. Years ago, this was done using a separate mechanical speed controller with a small motor or hand crank to change the reduction ratio inside the controller. A common type was a “reeves” speed change controller that consisted of a v-belt drive with pulleys on which the diameter of the pulleys could be changed by controlling the width of the pulley grooves. These types of speed adjustment controllers were high maintenance and difficult to keep on the desired speed settings. Today, motor speeds can be changed electronically using a variable frequency drive (VFD). The VFD is a device used in a drive system consisting of three main sub-systems: AC motor, main drive controller assembly, and drive operator interface. It has been available for years, but in recent times it has become very dependable and more economical to use.

The VFD operates by changing the frequency and voltage of the electricity supplied to the motor. As these two items change, the speed of the motor changes. The speed range can vary from 10% to 100% of the normal speed (rpm) of the motor. If it is desirable to operate a piece of equipment at several different speed settings, the VFD drive is the best choice.

One caution in using a VFD drive is to remember that as the speed is reduced, the torque needed to start the machine increases. Thus, a piece of equipment such as a conveyor that starts at high speed may not have enough starting torque when trying to start it at a lower speed. A standard VFD drive main-

tains a constant torque over its speed range. If the drive is to be started using a reduced motor speed, the VFD needs to be equipped with a torque booster. This feature is available. Detailed information about variable frequency drives (VFD's) is available on-line using the Wikipedia free encyclopedia. The motor being controlled by the VFD needs to be capable of operating at different speeds.

FIXED SPEED DRIVES

For equipment operating at a fixed speed for which a motor and direct coupled gear reducer will not provide the correct speed, a speed reduction, provided by a v-belt or chain drive, is installed between the motor and the gearbox, or possibly between the gear box and the machine. V-belt drives are usually used for systems connecting higher speed shafts with lower speed shafts, while chain drives are used for slower speed drive reductions.

Chain drives are often used when the power being transferred from the drive to the equipment is substantial. Chain drives are made of all metal components while in belt drives, the belts are normally made of rubber or other pliable or flexible material.

Belt drives transfer power by friction between the belt and the pulleys on the drive. Chains transmit power by metal to metal contact. Both types of reduction have been available for many years with the chain type drive being the oldest, dating back many centuries.

V-BELT DRIVES

A v-belt drive consists of two pulleys connected by a belt that wraps around both. The belt transfers power from one pulley to the other. Most belt drives transfer power through the friction of the belt gripping the surface of the pulley groove. Some belts and pulleys are built with cleated surfaces that allow the belt to mesh into slots on the pulley surface and are known as cog-belt drives.

The belts themselves are formed in a wedge shape to fit

omas keeps renewing its machinery

Our aim is to reach the highest:

performances - ease of maintenance

hygiene standards - cost effective.

Thanks to our R&D department and field experience Omas is proud to present
"MICHELANGELO" designed to get the best calibrated and purified semolina.



Italian Excellence

omas
www.omas-srl.com

down into the groove on the pulley. The tighter this wedge fits into the pulley groove, the greater the transfer of power in the belt drive as belt slip is minimized or eliminated. All belt drives need to be tight enough to avoid slipping on the pulley surfaces. The first v-belt drive sections produced in

the slower shaft 1 revolution.

When designing a v-belt drive, there are certain factors that must be considered. The first is the service factor. Typical service factors vary from 1 to 1.8, depending on the type of machinery being driven, the torque capabilities of the driving motor, and the num-

of the smallest pulley on the drive must be large enough that the wrap length of the belts in the pulley grooves is long enough to transmit the power from the small pulley to the larger pulley. Tables for the minimum recommended small pulley diameter are also available in belt drive design and selection sections of catalogs, etc.

The third factor entering into a proper belt design is to adjust the rated hp per belt found in belt and sheave-size tables to compensate for the distance between the shafts the two pulleys in the drive are mounted on. This is known as the "arc-length-correction" factor. This is based on the amount of wrap the belts have on each pulley. The closer the shaft for the smaller pulley is to the shaft of the larger pulley, the less the wrap length of the belt on the smaller pulley.

The last thing is that the belts must be kept properly tensioned in the drive to make sure they are drawn fully and tightly into the grooves on the pulleys. As stated earlier, most belt drives transfer power by the friction between the belt surface and the pulley surface. Thus, one of the shafts has to be adjustable or move sideways to keep the belts properly tensioned.

CHAIN DRIVES

Chain drives are used when large amounts of power are to be transferred in confined areas or precise control of speed ratios in the drive must be maintained.

When kept in good repair, they are not subject to slippage and do not depend on friction to transfer the power.

A chain drive is made up of a chain

One caution in using a VFD drive is to remember that as the speed is reduced, the torque needed to start the machine increases.

large quantities are referred to as "classic" belt sizes, A, B, C, D, or E. In later years, the stronger but narrower wedge belt sizes 3V, 5V or 8V have become the standard because they transfer more power per belt and require less space.

Regardless of whether a classic drive belt or the newer wedge drive belt is chosen, the speed reduction provided by a belt drive is determined by the diameters of the two pulleys used in the drive. As an example, if the faster shaft in the drive turns 1800 rpm, such as a motor shaft, and the required output speed of the drive shaft is 1200 rpm, the drive ratio would be the speed (rpm's) of the faster shaft divided by the speed of the slower shaft. This drive then would have a required drive reduction of 1800/1200 or a reduction of 1.5. Carrying this further, the diameter of the faster shaft pulley is multiplied by the ratio (1.5) to get the diameter of the slower shaft pulley. The faster shaft pulley is always smaller in diameter than the slower shaft pulley. In this drive, the faster shaft has to turn 1.5 revolutions to turn

the slower shaft 1 revolution. Copies of these service factor tables may be found on-line or in the design sections of v-belt manufacturers. One exception that should be applied to all belt-driven equipment in grain handling or processing is that a standard service factor of 2 is used. This comes from the fact that these drives are used in systems where equipment may choke, or belt slippage on the drive might cause enough friction to ignite the belt and the atmosphere around the drive. Thus, if a 10-hp motor is required to drive a piece of equipment, the v-belt drive design hp is determined by multiplying the actual motor hp by the service factor. In this case, although the equipment is driven by a 10-hp motor, the v-belt drive would be designed to transfer 20 hp. In doing this, should the equipment choke and the input shaft stop, the belt friction in the drive would be sufficient to keep the motor from turning. The stalled motor should then trip the heaters in the motor starter and shut the motor down.

The second factor is that the diameter

Enzymes | Oxidizing Agents | Bromate Replacer | Vitamin Premixes | Vital Wheat Gluten | Raw Materials for Baking | Baking Premixes | Laboratory Equipment

www.flour-improver.de

Mühlenchemie | Kurt-Fischer-Straße 55 | D-22926 Ahrensburg, Germany | Tel.: + 49 (0) 41 02 / 202-001



For more information, see Page 118.

FRANCE

SPAIN

SINGAPORE

CHINA

JETcc

The new bucket on the market



Greater capacities

Thicker front lip and corner design

Stackable
Stackable
Stackable
Stackable

JETcc
14.5"
STIF

Premium virgin white
polymer material

EUROPE
STIF SAS (Head office)
Factory
sales@stifnet.com
www.stifnet.com
France

STIF IBERICA
Sales office
ventas@stifiberica.es
Spain

ASIA
STIF (SUZHOU)
Factory
sales@stif.cn
www.stif.cn
China

STIF ASIA
Sales office
sales@stif.com.sg
Singapore

STIF

For more information, see Page 118.

and two wheels (sprockets) with teeth that fit into each link in the chain as the chain passes over the wheel. The chain links are made up of rollers that fit in the grooves between the teeth of the sprocket. These rollers are connected by side plates on each side that straddle each tooth on the sprocket as that chain passes over the sprocket. The distance from the center of one roller in the chain to the next is called the pitch length. Standard chain is referred to as roller chain and the size of the chain is expressed in the pitch length in 1/8-inch increments. This length is shown as the first number in the chain length size, a No. 60 chain has a pitch length of $6 \times 1/8 = 3/4$ inches. Roller chain sizes used in most chain drives vary from a No. 35 to a No. 240. Though chains normally come in single strands, double and triple strands are available to transmit

greater power requirements through the drive.

When designing a chain drive there are again several factors that have to be considered. First is the "Class of Service" for the type of machine being driven and the ruggedness required for the application. From this, the design horsepower for the drive can be determined similar to the method used in designing v-belt drives. Second, using the design hp and the speed of the shaft for the smaller sprocket, select from the manufacturers' chart the recommended chain size and minimum number of teeth required for the smaller sprocket. Determine the speed reduction ratio between the two shafts, just as in v-belt designs, and multiply the number of teeth on the small sprocket times the ratio to determine the number of teeth on the large sprocket. Based on the shaft centers and the diameters of the sprockets,

calculate the length of chain required for the drive. Again, a mechanism has to be available to keep the chain taught and tightly wrapped around the sprockets.

This article examines some of the highlights of speed reduction methods. Most supplier catalogs contain the procedures and tables for fully designing a proper speed reduction drive. A drive should always be designed by a qualified knowledgeable person. **WG**


Fred Fairchild is a professor in the Department of Grain Science and Industry at Kansas State University. Prior to coming to Kansas State in 1994, he worked in the industry designing, construction and commissioning of numerous mill facilities. He is a licensed professional engineer. He can be reached by e-mail at fjf@k-state.edu.


We want to hear from you — Send comments and inquiries to worldgrain@sosland.com. For reprints of WG articles, e-mail reprints@sosland.com.

WALINGA INC.

SHIP UNLOADER / BARGE UNLOADER

ENGINEERED TO CLIENT SPECIFICATIONS





200 TONNES/HR

Walinga has been manufacturing pneumatic conveying systems for more than 35 years. Working closely with clients, Walinga engineers ensure that every machine performs its intended task. Walinga ship unloaders are designed to deliver on your demands.

Contact:
 Tom Linde
 +1-519-823-3265
thl@walinga.com

John Broekema
 +1-519-546-7520
jmb@walinga.com

SCAN FOR VIDEO



For more information, see Page 118.

Innovation through experience



Milling and Dry Food

High-precision fabrics for screening
and filtration in the production
of cereal products

Filtration Solutions

Headquarters
Sefar AG
Hinterbissastrasse 12
CH-9410 Heiden
filtration@sefar.com

Sefar Inc.
Kansas City
4221 NE 34th Street
kcfiltration@sefar.us

www.sefar.com

For more information, see Page 118.

